SPGR Sub-Project Completion Report

On

Coordinated project on improvement of agroforestry practices for better livelihood and environment: BAU component

Duration: May 2011 to June 2014

Executing Organization

Department of Agroforestry
Bangladesh Agricultural University, Mymensingh

Submitted to

PIU-BARC, NATP: Phase-1
BARC Complex
Farmgate, Dhaka-1215

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List of Abbreviations

Av. = average

BARC =Bangladesh Agricultural Research Council

BAU =Bangladesh Agricultural University

BBS = Bangladesh Bureau of Statistics

BFRI = Bangladesh Forest Research Institute

BSMRAU = Bangabandhu Sheikh Mujibur Rahman Agricultural University

BJRI = Bangladesh Jute Research Institute

CAI = Current Annual Increment

C*i* = Crop yield under intercropping

cm = Centimeter

C*s* = Crop yield under sole cropping

CU = Chittagong University

DMRT = Duncan's Multiple Range Test

e.g. = exempli gratia - for example

Ed.= edited; edition

et al. = *et alibi* (= and elsewhere)/*et alia* (= and others)

etc = *et cetera* (= and the others and so forth)

FAPAD = Foreign Aided Project Audit Directorate

Fig. = Figure

g = gram

GTI = Graduate Training Institute

ha = hectare

HSC = Higher Secondary Certificate

i.e = *id est* (= that is)

IPM = Integrated Pest Management

J = Journal

kg = kilogram

KU = Khulna University

LER = Land Equivalent Ratio

LSD = Least Significant Difference

MAI = Mean Annual Increment

MS = Master of Science

No. = Number

NRM = Natural Resource Management

PhD = Doctor of Philosophy

PIU = Project Implementation Unit

RCBD = Randomize Complete Block Design

Sci. = Science

SDC = Swiss Agency for Development and Cooperation

Sp = Specie

Spp = species

SPGR = Sponsored Public Goods Research

SSC = Secondary School Certificate

Std = Standard

t = ton

tha^{-1} = ton per hectare

T*i* = tree yield under intercropping

Tk. = Taka

T*s* = tree yield under sole cropping.

viz. = *videlicet* (= namely)

Yr = Year

Executive Summary

The coordinated project on improvement of agroforestry practices for better livelihood and environment: BAU component has been implemented at Mymensingh and Jamalpur districts to improve traditional and modern agroforestry systems practiced in the charland areas for promoting livelihood and environmental upgradation in the selected char areas during May 2011to June 2014. Char Kalibari and Char Gobadia under Sadar upazila of Mymensingh district and Topkerchar and Char Ghosherpara under Melandah upazila of Jamalpur district were selected as study areas. In total 200 farmers (fifty farmers from each of the char area) were selected following a multistage random sampling procedure for benchmark survey. Data were collected with the help of a pre-tested questionnaire. In Mymensingh district, people used major portion of their land for vegetable cultivation while in Jamalpur district major portion of land were utilized for rice cultivation. In the Mymensingh area total land of the farm holders are in the stable char area and in Jamalpur some portion (20-25 %) of the land of large farmers are in unstable char areas, which are inundated every year. Majority of the peoples are day labourer and 30-35% is agriculture based. Mean annual income of the farmers of these char areas of Mymensingh and Jamalpur was Tk. 39000 with a range of Tk. 15000-125000. Though different types of tree and vegetables/crops species were found in these char areas but tree-vegetables/crops association was seldom found. Interestingly, farmers of these chars showed interest to grow vegetables/crops in association with trees as agroforestry. After completion of the benchmark survey, 19 (nineteen) farmers were selected of which 10 (ten) from Mymensingh and 9 (nine) were from Jamalpur for introducing new agroforestry practices as well as for making improvement of existing one. Total 7886 tree saplings of different timber and fruit tree species were planted on 6.85 ha of charland of which 6715 in Mymensingh and 2171 in Jamalpur districts. These tree species were akashmoni (*Acacia auriculiformis*), eucalyptus (*Eucalyptus camaldulensis*), mahogony (*Swietenia macrophylla*), lombu (*Khya* sp.), karanja (*Pongamia pinnata*), hijal (*Barringtonia acutangula*), mango (*Mangifera indica*), guava (*Psidium guajava*), lemon (*Citrus* spp.), jujube (*Zizyphus* spp.) and papaya (*Carica papaya*). Different summer vegetables/crops viz. kangkong, indian spinach, amaranth, jute shak, rice, etc., in the summer season and different winter vegetables/crops, viz., bottle gourd, bed amaranth, cucumber, mungbean, mustard, seasame, carrot, radish, chilli, sweetgourd, coriander, bittergourd, potato, sweetpotato, etc., were cultivated in winter season in association with planted tree saplings. It was found that yield of all vegetables/crops was gradually decreased with increasing the size of tree saplings

over time. It is mentionable that during winter 2013 i.e. after three years of plantation only 25-35% vegetables/crops yield was reduced in combination with different trees compared to open field condition. LER for different combination during summer and winter season, 2013 was more than one which indicated benefit of combined production of summer vegetables and fruit trees. Growth of all planted tree saplings were recorded in terms of height and girth increment for every year (2011-2014). Mean Annual Increment (MAI) of all tree species was statistically similar both for height and girth increment. Critically it was found that MAI value was numerically little higher in control condition compared to the association with vegetables/crops. Six different agroforestry cropping pattern or models were proposed for charland from the experience of last three year (2011-2014) experiment in Mymensingh and Jamalpur char areas. Income from the different plots in Mymensingh and Jamalpur char areas of this project gradually increased from initial year (2010-2011) to current year (2013-2014) with a handsome return. Total gross return in Mymensingh areas in the financial year 2013-2014 was Tk.113521 and Jamalpur it was Tk. 67775.4 which were 7% higher and 4.2% lower compare to previous year (2012-2013), 30 and 4.2% higher compare to the year 2011-2012 and 84 and 74% higher compare to the 2010-2011 (before project execution). Training was organized every year (2011, 2012 and 2013) separately for Mymensingh and Jamalpur char areas with selected farmers. In each year, 140 farmers were trained of which 70 were from Mymensingh and 70 from Jamalpur. Thus a total of 420 {(70 + 70) × 3} farmers were trained up by different resource persons on different agroforestry activities, environment, livelihood and social safeguard aspects. Present status of different parameters of livelihood and environment are relatively better compared to that of initial stage (before SPGR sub-project implementation). Upon participation in the exchange visit, it appeared that all the six components of this coordinated project made significant progress towards achieving the targeted goal.

1. Sub-project title: Coordinated project on improvement of agroforestry practices for better livelihood and environment: BAU component

2. a) Principal Investigator: Professor **Dr. G.M. Mujibar Rahman**

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4. Duration: From May 2011 to June 2014

5. Date of approval (by the Executive Council/signing of LoA)**:** 15.05.2011

6. Total approved Budget (Taka): 65,46,930/-

Total fund released upto June, 2014 (Taka): 65,46,930/-

Total fund spent upto April, 2014 (Taka): 65,46,631.60

Unspent fund upto April, 2014(Taka): 298.40

Reason for the balance: Budget kept for utility and other service charges were not exhausted fully as because cost of this head was fixed tentatively during preparation of the project proposal.

7. Justification of undertaking the sub-project

The human civilization initiated with the cultivation of crops by the primitive people being close to or nearby their habitat in the forest. Traditionally it was agroforestry. In the highly civilized era, the modern people are going back to agroforestry with the principle of growing trees in all possible places including homesteads and farmlands. In both cases, there is association of trees with crops and/or animals which is the fundamental principle of agroforestry. Agroforestry is aimed at the creation of natural environment as well as to increase diversified agricultural products through maximum utilization of the land retaining its productive qualities. Homegarden agroforestry is an age-old practice and an integral part of the traditional farming systems in Bangladesh, although it is relatively a new concept to the farmers community. Agroforestry system has been emphasized for checking soil erosion and desertification, to improve soil fertility and productivity, to increase humidity and decrease air temperature and to bring equilibrium to the ecosystem. At present it is an agro-ecological approach to tackle complex problems of interaction between the woody perennial and productive components of agriculture. Agroforestry does not mean planting trees in the fields or other places; rather it provides farmers with an

effective land management system that can ensure more production in a balanced ecological environment. According to Saka, *et al.*, (1990) agroforestry can provide a sound ecological basis for increased crop and animal productivity, more dependable economic returns, and greater diversity for social benefits on sustained basis. Hossain, *et al.*, (1994) through a micro level study on biomass production and utilization showed that under further growth in population and current level of production and land utilization, there would be a severe shortage of bio-energy in near future if proper development of agroforestry systems could not be attained. Hossain and Bari (1996) observed that the cropland agroforestry is expanding as an insurance against crop failure and extra economic benefit in the northern regions of Bangladesh. They mentioned that without agroforestry the farming systems in Bangladesh can not sustain. According to Haque (1996), at least 20 percent of the total land area of the country outside the tree coverage of forest, may be brought under the coverage of trees if agroforestation is done properly and extensively. Through agroforestry, the people of Bangladesh can get more food, enough timber as well as better environment to live in Jamalpur and Mymensingh districts comprise a vast charland area which is frequently inundated due to monsoon flood almost every year. These two districts have approximately 35-40 percent charland. In Jamalpur district there are seven upazilas of which except Jamalpur sadar, the rest six upazilas, viz., Dewangonj, Bakshigonj, Madargonj, Islampur, Melandaha and Sarishabari have vast charland areas. According to population census wing of BBS (2006), the char areas of this districtare ranging from 35 to 64 percent depending on upazilas. Thus, the district possesses around 767 sq. km char areas. A total of 378000 homesteads are present in Jamalpur district of which 120000 to 135000 homesteads are in char areas. In Mymensingh district there are 12 upazilas of which Mymensingh sadar, Ishwargonj, Trishal, Gaffargaon and Gouripur upazila are char inhabited area containing about 584 sq. km charland areas. These five upazilas contained atleast 361000 homesteads of which 25 percent, i.e., 90000 homesteads remained in char areas (BBS, 2006). A large number of populations are living in these char areas and maintaining their livelihood through char based farming systems. In the char areas, more than 60 percent people do not have any cultivated land other than the homestead only. Therefore, for improving the livelihood of the charland people, increase of productivity of the homestead farming system is necessary.

8. Sub-project objectives

(i) Improvement of traditional and modern agroforestry systems practiced in the farmland and homestead in the charland areas of Jamalpur and Mymensingh districts.

(ii) To assess the impact of improved farming systems in terms of livelihood changes, biomass contribution in soil and environmental upgradation in the locality.

9. Methodology: During the project period (May 2011 – June 2014) study area selection, benchmark survey, sample farmer selection, timber and fruit trees seedling plantation, vegetables/crops cultivation in association with trees, tree growth observation, farmers income estimation from research plots, agroforestry models development, farmers training, monitoring, environmental change and uplift of livelihood status and social safe guard, view exchange among other components of this sub-project, etc., were successfully done. Methodology of each of these activities was as follows:

9.1 Study area: Two char villages, viz., Char Kalibari and Gobadia of Mymensingh Sadar upazila of Mymensingh district and Topkarchar and Ghosherpara under Melandaha upazila of Jamalpur district were selected for the benchmark survey (Fig. 1).

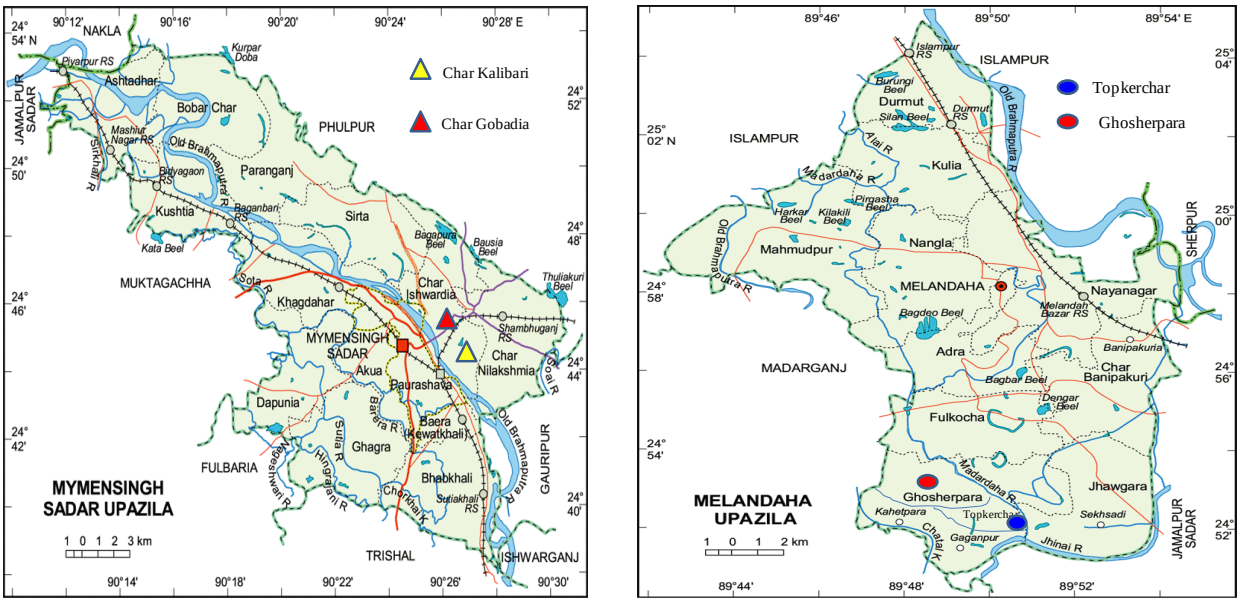

Fig. 1. Map showing the selected chars of (A) Sadar Upazila of Mymensingh and (B) Melandaha Upazila of Jamalpur district

9.2 Benchmark survey: A total of 50 farmers from each of selected char were selected following a multistage random sampling procedure. Thus, there were altogether 200 farmers selected for this benchmark survey. Data were collected with the help of a pre-tested questionnaire. Data related to land category, farm category, soil characteristics, family size, age of the farmers, education level, occupation, farmer's knowledge about agroforestry, annual income of the farmers, existing tree and crop species in the farm land, farmer's preference for plantation of trees and existing agroforestry systems practiced in the farmer's field were collected. Data collected from the respondents (samples) had been verified, compiled, tabulated and analyzed statistically according to the objectives of the study. In some cases, qualitative data had been converted into quantitative

data by means of suitable scoring to facilitate interpretation. Pearson's product moment Co-efficient of correlation was used to explore the relationship between the concern variable.

9.3 Selection of the Sample farmers: Based on the benchmark survey total twenty farmers were selected from the four char villages of Mymensingh and Jamalpur district of which 10 were from each district. Detail information of these farmers were further collected using a separate questionnaire. Collected data from these sample farmers had been verified, compiled, tabulated and analyzed using SPSS software.

9.4 Tree sapling plantation: Almost 8000 saplings of different timber and fruit tree species were planted on 6.85ha of selected farmer's charland, using Randomized Complete Block Design (RCBD) with 4 replications (Table 1). Tree species were - akashmoni (*Acacia auriculiformis*), mahogony (*Swietenia macrophylla*), lombu (*Khya* sp.), eucalyptus (*Eucalyptus camaldulensis*), mango (*Mangifera indica*), lemon (*Citrus* spp.), jujube (*Zizyphus* spp.), guava (*Psidium guajava*), papaya (*Carica papaya*), hijal (*Barringtonia acutangula*) and karanja (*Pongamia pinnata*). All these species of trees were selected based on the preferences of the selected farmers.Vegetables/crops component were also included along with these tree species using the same design.

Table 1. Tree saplings planted in project areas of Mymensingh and jamalpur

Year	District	No. of Sapling	Area (ha)
2011	Mymensingh	2240	1.86
	Jamalpur	571	0.79
	Total	2811	2.65
2012	Mymensingh	4475	2.98
	Jamalpur	1600	1.22
	Total	5075	4.2
Grand Total		7886	6.85

9.5 Planting material: Different tree species (Timber, fruit and soil conserving species), different summer vegetables/crops in the summer season, different winter vegetables/crops in winter season were used as planting materials (Table 2). Summer vegetables/crops were kangkong, indian spinach, amaranth, jute shak, rice and okra. Different winter vegetables/crops were bottle gourd, red amaranth, cucumber, mungbean, mustard, seasame, carrot, radish, chilli, sweetgourd, coriander and bittergourd (Table 2).

Table 2. Planted trees and vegetables/crops species in the study area

Trees and Vegetables/Crops			
Common name	Scientific name	Common name	Scientific name
Trees		4. Tomato	*Lycopersicon esculentum*
1. Eucalyptus	*Eucalyptus camaldulensis*	5. Red amaranth	*Amaranthus tricolor*
2. Akashmoni	*Acacia auriculiformis*	6. Cucumber	*Cucumis sativus*
3. Mahogony	*Swietenia macrophylla*	7. Indian spinach	*Basella alba*
4. Lombu	*Khya sp.*	8. Bitter gourd	*Momordica charantia*
5. Mango	*Mangifera indica*	9. Radish	*Raphanus sativus*
6. Guava	*Psidium guajava*	10. Mungbean	*Vigna mungo*
7. Jujube	*Ziziphus jujuba*	11. Seasame	*Seasamum indicum*
8. Papaya	*Carica papaya*	12. Amaranth	*Amaranthus spp.*
9. Lemon	*Citrus spp.*	13. Jute shak	*Corchorus spp.*
10. Hijal	*Baringtonia acutangula*	14. Chilli	*Capsicum annuum*
11. Karanja	*Pongamia pinnata*	15. Rice	*Oryza sativa*
Vegetables/crops		16. Mustard	*Brassica spp.*
1. Bottle gourd	*Lagenaria siceraria*	17. Carrot	*Daucus carota*
2. Sweet gourd	*Cucurbita moschata*	18. Okra	*Abelmochus esculentus*
3. Coriander	*Coriandrum sativum*		

9.6 Vegetable cultivation and intercultural management: Seeds of winter vegetables, i.e., carrot, radish, chilli, sweetgourd, coriander and bitter gourd were sown through broadcasting method after land preparation (carrot, radish, chilli and bittergourd) and dibbling (sweetgourd and bittergourd) method. Seeds of all winter vegetables were sown during 15 -25th October. Summer vegetables, i.e., kangkong, indian spinach, amaranth and okra were sown after land preparation in broadcast (amaranth and indian spinach), dibbling (okra) and line sowing (kangkong) method. Seeds of all summer vegetables were sown during 15 -25th April. After germination all necessary cultural operations like thinning, gap filling, weeding, fertilizing, irrigation, pest control, etc., were done properly. Individual plot size for all vegetable was same (12′ × 24′).

9.7 Experimental design and layout

(a) Winter season 2011: Different vegetables/crops species were cultivated in association with 11 different timber and fruit tree species using Randomized Complete Block Design (RCBD) with 4 replications. Performance of these vegetables/crops in association with different tree species was observed. After inclusion of vegetables/crops along with trees, the data were analyzed using two factorial RCBD design for observing the interaction or influence of both components on each other.

(b) Summer season 2012: Summer vegetables were planted in association with different trees following two factorial Randomized Complete Block Design (RCBD) with 4 (four) replications comprising eleven different tree species (Factor A) and four different summer vegetable species (Factor B). Tree species were planted maintaining a strip method with 12′ × 12′ spacing during April, 2011 in the study site. Total 528 saplings of 11 different species were transplanted of which 48 saplings for each species. Necessary silvicultural management activities like watering, cleaning, weeding, fertilizing, branch cutting, bamboo stick setting were done in time for proper growth and development of all tree saplings.

(c) Winter season 2012: Using nine tree species and six winter vegetable species three different experiments were conducted. The experiments were (i) Performance of four winter vegetables in association with akashmoni tree (ii) Sweet gourd cultivation along with different tree species during winter season (iii) Effects of different tree species on the growth and yield of bitter gourd. Each experiment was done following Randomized Complete Block Design (RCBD) with 4 (four) replications.

(d) Summer season 2013: Using ten tree species and four summer vegetable species three different experiment were studied. The experiments were (i) Performance of summer vegetables in association with different fruit trees (ii) Summer vegetables cultivation in association with different timber trees (iii) Summer vegetables production in association with hijal and karanja trees. Each experiment was executed following Randomized Complete Block Design (RCBD) with 4 (four) replications.

(e) **Winter season 2013:** Using planted tree species and different winter vegetable species three different experiments were conducted. The experiments were (i) Performance of seven winter vegetables in association with akashmoni tree (ii) Sweet gourd cultivation along with different fruit tree species during winter season (iii) Sweet gourd cultivation along with different timber tree species during winter season. Each experiment was done following Randomized Complete Block Design (RCBD) with 4 (four) replications.

9.8 Growth measurement of tree species: Growth of all planted tree saplings were recorded as height and girth every year (2011-2014). During the year 2011first time data were record in plantation time (April, 2011) and second time data were recorded on 31 December, 2011. During the year 2012 first data were the last data of the year 2011 and second time data was recorded on 31 December, 2012. During the year 2013 first data was the last data of the year 2012 and second time data was recorded in the 31 October, 2013. During the year 2014 first data was the last data of the year 2013 and second time data was recorded in the 28 April, 2014. Girth was measured using the formula: $G = 2\Pi r$, where, r = radius. Difference between the first and second time

recorded data in each season was treated as increment separately for height and girth. Girth of all trees was measured at 8 inch above the ground level. Current Annual Increment (CAI) and Mean Annual Increment (MAI) were also recorded for all tree species. MAI = ∑CAI ÷ Age (Year).

9.9 Sampling and Data collection: Data were collected from randomly selected individual plants of all winter and summer vegetables. Plant height or length (cm), number of branches per plant, leaves per plant, fruit per plant, root length (cm) for carrot and radish, individual fruit weight (g) for chilli, bittergourd, sweetgourd, etc., were noted. For yield measurement, data were recorded from individual plots and it was converted as tha^{-1}. Fruit yield, i.e., lemon, guava and mango were recorded from all trees from different treatments and it was also converted as tha^{-1}. Land Equivalent Ratio (LER) was also recorded from sole and intercrops yield of fruit trees and summer vegetables as **LER = C*i*/C*s* + T*i*/T*s*;** Where, **C*i*** = crop yield under intercropping, **C*s*** = crop yield under sole cropping, **T*i*** = tree yield under intercropping, and **T*s*** = tree yield under sole cropping.

9.10 Environmental and social safeguard situation: Environmental situation and social safeguard situation were observed based on different parameters. For this purpose field monitoring and farmers interview were observation tools. Before and after the project implementation different parameters regarding environment, viz., biodiversity, soil quality, agro-chemicals, pollution status, etc., and regarding social safeguard, viz., productivity, annual income, technical knowledge, employment generation, market linkage, women participation, agroforestry models development, etc., were compared based on field monitoring and farmers opinion.

9.11 Statistical analysis: The recorded data were compiled and analysed by RCBD design to find out the statistical significance of the experimental results. The means for all recorded data were calculated and the analyses of variance for all the characters were performed. The mean differences were evaluated by Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984) and also by Least Significant Difference (LSD) test.

9.12 Farmers income from individual plot: Different vegetables/crops were cultivated during this winter/summer season along with planted trees. Yield of these vegetables/crops and tree products were recorded along with their market value. Recorded market value from respected plots was also compared with the last year income during summer season from the same plot.

9.13 Farmers training: 70 farmers from Mymensingh and 70 from Jamalpur were randomly selected for training program for every year from 2011-2014. Total 420 (140 × 3) farmers were trained regarding different agroforestry activities. In these training periods different resource persons were involved for training purpose.

9.14 Exchange visit: The Member Director, NRM Division who was the coordinator of this coordinated sub-project arranged exchange visit for all the scientists engaged with the six different components with a view to share experience, knowledge, views of the participating farmers and other related aspects.

10. Results and discussion

Results obtained through different activities of the sub-project are presented in this section separately under different headings:

10.1 Benchmark survey

Characteristics of the respondents

The people of these char area were used their land for different purposes like homestead, agriculture (rice based), vegetables production, tree plantation, fallow and so on (Table 3). In Mymensingh district, people used major portion of their land for vegetable cultivation (average 35%) while in Jamalpur district major portion of land was utilized for rice cultivation (average 50%). In both the districts, longer portions of land remained unutilized (Table 3). Farm size of these char areas can conveniently be classified into three categories, viz., small, medium and large (Table 3). More than 50 % of the farm is small (<0.05 ha), 30-40 % medium (0.05-.5 ha) and 10-15 % large (>0.5 ha) in size (Table 4). Farmers having small holdings usually worked in the large category holdings as day labourer and only medium categories farm holder work in their own land. In Mymensingh area total land of the farm holders are in the stable char area and in Jamalpur some portion (20-25 %)of the land of large farmers are in unstable char areas, i.e., this portion is flooded severely every year several times. Soil pH, colour and texture of these char areas are 6.5 to 7.8, greyish to grey-brown and silty-loam to silty-clay (Table 5). Family size of these chars areas mostly medium in size, a few small and rest are large in size (Fig. 2). All the selected char areas having medium size family (4-7 member/ family) constituted 60-75% of the total farm family (Fig. 2). Age category and education level of the people of these char areas are shown in Fig. 3 and Fig. 4. The occupations of the peoples of these chars are often different such as like agriculture, day labourer, business, service and others (Fig. 5). Majority of the peoples are day labourer and 30-35% is agriculture based. Knowledge of people about tree plantation, agroforestry and environment are not satisfactory (Fig. 6). Mean annual income of the farmers of char Kalibari, Gobadia, Topkerchar and Gosherpara were Taka 47500, 43500, 35000 and 30000. Annual income of these chars ranges from 20000-120000, 25000-110000, 15000-1250000 and 18000-100000 (Table 6). A total of 25 tree species were found in these chars of which seven timber species, twelve fruit species and remaining six species are of different categories, viz., fuel, fodder, ornamental etc. Among the timber species, eucalyptus was identified as the dominant

species which ranked as number one followed by akashmoni and mahogony as second and third abundant species. In case of fruit tree species, mango and jackfruit were the dominating species (Table 7). In the selected char areas, 25 crops and vegetables species were found of which there were 9 crops and 16 vegetables species (Table 8). As regards preference of timber species to be planted in the farmland, eucalyptus, mahogony and akashmoni emerged as the most popular tree in both the char areas (Table 9). In case of crops/vegetables, farmers preferred to cultivate radish, cucumber, mustard, red amaranth and chilli in the char areas of Mymensingh district while the farmers of Jamalpur district preferred chilli, radish, tomato, sweet gourd (Table 10). A few agroforestry systems mostly rice dominated were found to be practiced sporadically in these char areas. Only a few farmers (5-10%) are practising vegetable based agroforestry systems (Table 11). Average tree population density and tree species density of the char inhabited areas of Mymensingh were 0.287 and 0.251 while these was in Jamalpur were 0.16 and 0.135 per $100m^2$ land area (Table 12).

Table 3. Land ctegory of farmers of different char areas of Mymensingh and Jamalpur districts

Location		Land category (% of mean total area)					
		Homestead	Agriculture (Rice based)	Vegetables	Trees	Fallow	Others
Mymensingh	Kalibari	10	10	40	8	25	5
	Gobadia	12	18	30	10	20	10
	Average	11	14	35	9	22.5	7.5
Jamalpur	Topkerchar	8	45	20	7	15	5
	Ghosherpara	11	50	15	5	20	5
	Average	9.5	47.5	17.5	6	17.5	5

Table 4. Farm ctegory based on land owenership in different char areas of Mymensingh and jamalpur districts

Location		Farm category (%)		
		Small (< 0.05 ha)	Medium (0.05-0.5 ha)	Large (> 0.5 ha)
Mymensingh	Kalibari	50	35	15
	Gobadia	45	45	10
	Average	47.5	40	12.5
Jamalpur	Topkerchar	60	30	10
	Ghosherpara	50	35	15
	Average	55	32.5	12.5

Table 5. Soil characteristics in different char areas of Mymensingh and jamalpur districts

Location		Soil Characteristics		
		pH	Colour	Texture
Mymensingh	Kalibari	6.5-7.5	Greyish	Silty loam
	Gobadia	6.5-7.5	Greyish	Silty loam
Jamalpur	Topkerchar	6.8-7.8	Greyish-Brown	Silty clay
	Ghosherpara	6.8-7.8	Greyish-Brown	Silty clay

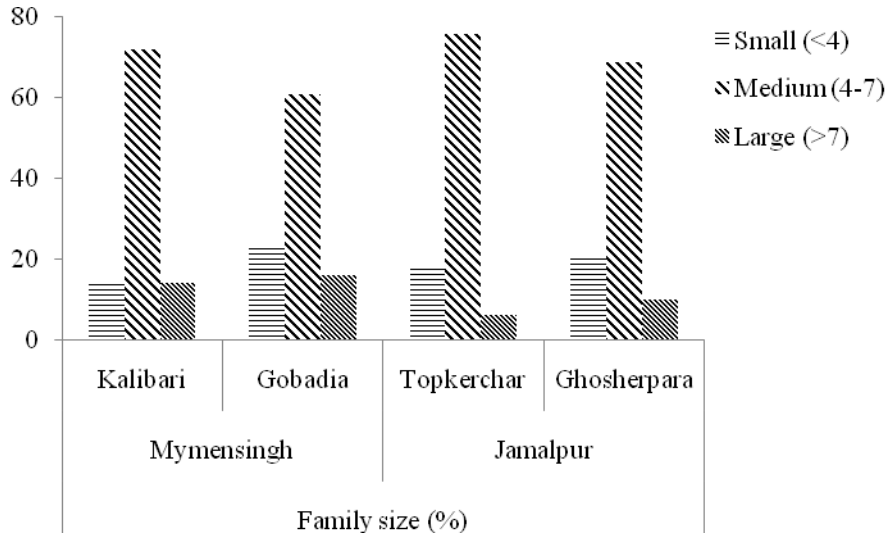

Fig. 2. Family size of farmers of different char areas of Mymensingh and Jamalpur districts

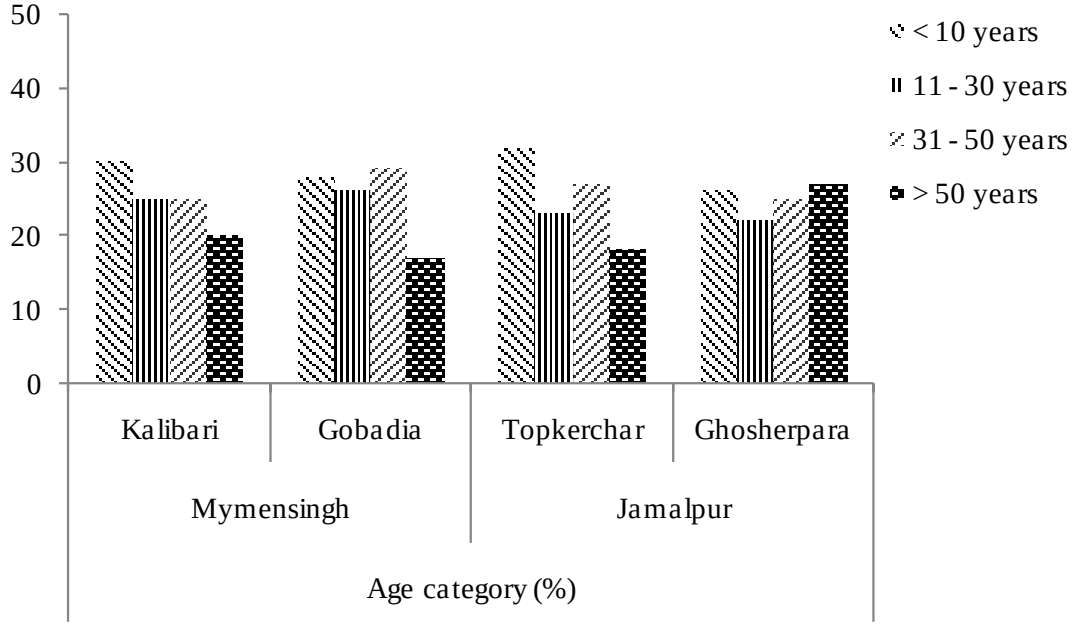

Fig. 3. Age category of farmers of different char areas of Mymensingh and Jamalpur districts

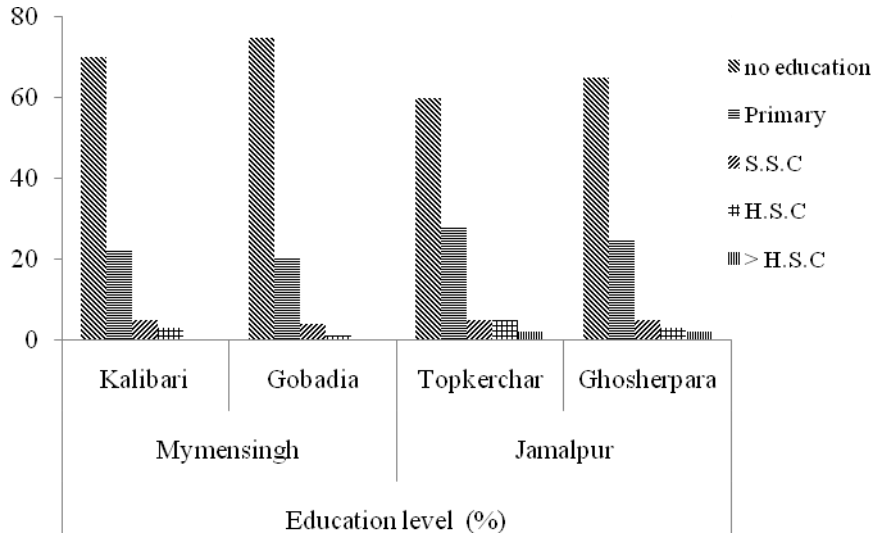

Fig. 4. Education level of farmers of different char areas of Mymensingh and Jamalpur

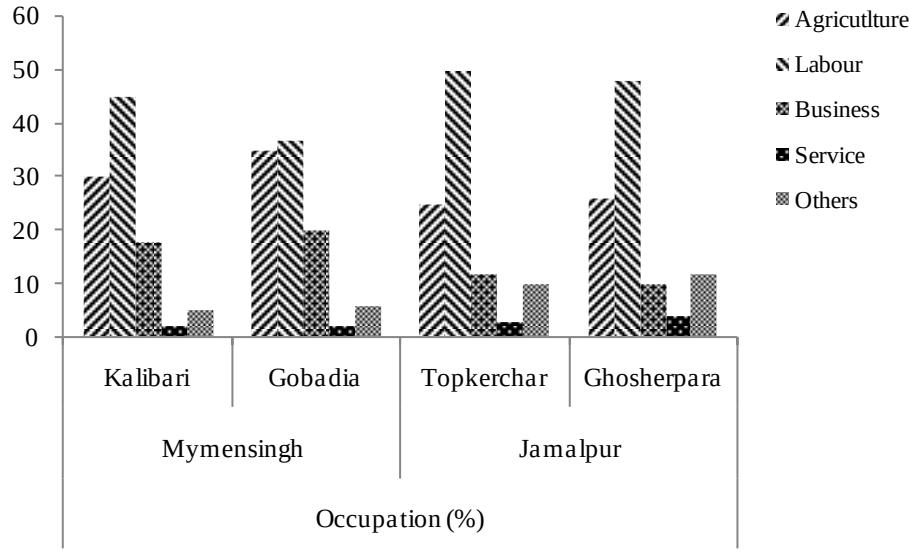

Fig. 5. Farmers' occupation of different char areas of Mymensingh and Jamalpur districts

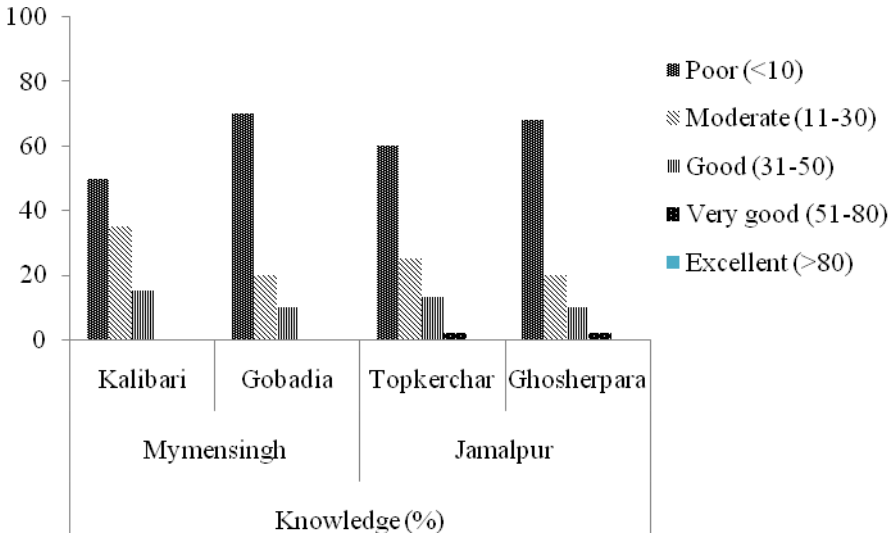

Fig. 6. Farmers' knowledge about trees, agroforestry and environment of different char areas of Mymensingh and Jamalpur districts

Table 6. Annual income of farmers from different char areaa of Mymensingh and Jamalpur

Location		Annual income (Tk./yr)		
		Mean	Range	Standard deviation
Mymensingh	Kalibari	47500	20000 - 120000	22169.9
	Gobadia	43500	25000 - 110000	17682.5
Jamalpur	Topkerchar	35000	15000-125000	19907.6
	Ghosherpara	30000	18000 - 100000	22260.3

Table 7. Existing tree species in the char areas of Mymensingh and Jamalpur Districts

Sl. No.	Name	% farmers possessing	Rank
Timber trees			
1	Eucalyptus (*Eucalyptus cameldulensis*)	100	1
2	Akashmoni (*Acacia auriculiformis*)	82	2
3	Mahogony (*Swietenia mahogoni*)	75	3
4	Kalo koro (*Albizia lebbeck*)	60	4
5	Sada koroi (*Albizia procera*)	60	4
6	Gamar (*Gmelina arborea*)	40	6
7	Raintree (*Albizia saman*)		8
Fruit Trees			
8	Mango (*Mangifera indica*)	100	1
9	Jackfriut (*Artocarpus heterophyllus*)	100	1
10	Guava (*Psidium guajava*)	82	2
11	Papaya (*Carica papaya*)	82	2
12	Banana (*Musa sapientum*)	75	3
13	Coconut (*Cocos nucifera*)	75	3
14	Betelnut (*Areca catechu*)	60	4
15	Lemon (*Citrus* spp)	50	5
16	Jujube (*Zizyphus jujuba*)	50	5
17	Tamarind (*Tamarindus indica*)	40	6
18	Blackberry (*Syzygium cumini*)	35	7
19	Hog plam (*Sponolias pinnata)*	30	8
Other trees			
20	Jiga (*Garuga pinnata*)	35	7
21	Ipil-ipil (*Leucaena leucocephala*)	50	5
22	Kadam (*Anthocephalus chinensis*)	30	8
23	Goraneem (*Melia azedarach*)	20	9
24	Shimul (*Bombax ceiba*)	13	10
25	Minjiri (*Cassia siamea*)	50	5

Table 8. Existing crops/vegetables species in the char areas of Mymensingh and Jamalpur Districts

	Name	% farmers possessing	Rank
Crops			
1	Rice (*Oryza sativa*)	85	1
2	Jute (*Corchorus spp.*)	75	2
3	Pulse (*Lathyrus sativus*)	75	2
4	Potato (*Solanum tuberosum*)	60	3
5	Maize (*Zea mays*)	60	3
6	Dhoincha (*Sesbania sesban*)	50	4
7	Mustard (*Brssica spp*)	50	4
8	Chilli (*Capsicum spp.*)	40	5
9	Millet (*Setaria italica*)	30	6
Vegetables			
10	Red amaranth (*Amaranthus tricolor*)	100	1
11	Bottle gourd (*Lagenaria siceraria*)	75	2
12	Okra (*Abelmochus esculentus*)	75	2
13	Cucumber (*Cucumis sativus*)	75	2
14	Bean **(***Lablab niger***)**	75	2
15	Sweet gourd (*Cucurbita moschata*)	75	2
16	Bittergourd (*Momordica charantia*)	60	3
17	Indian spinach (*Basella alba*)	60	3
18	Mustard (*Brssica spp*)	60	3
19	Amaranth (*Amaranthus spp*)	60	3
20	Brinjal (*Solanum melongena*)	60	3
21	White/Wax gourd (*Benincasa hispida*)	40	5
22	Carrot (*Daucus carota*)	30	6
23	Snake gourd (*Trichosanthes anguina*)	30	6
24	Aroids (*Colocasia alba*)	20	7
25	Teasle gourd (*Momordica dioica*)	20	7

Table 9. Farmers Priority for plantation of tree and fruit species in their cropland

Sl. No.	Species	Preparence of the farmers (%)	Rank
Mymensingh			
Timber trees			
1	Mahogony (*Swietenia macrophylla*)	100	1
2	Akashmoni (*Acacia auriculiformis*)	85	2
3	Eucalyptus (*Eucalyptus camaldulensis*)	70	3
4	Lombu (*Khya* sp.)	70	3
5	Mangium (*Acacia mangium*)	60	4
6	Gamar (*Gmelina arborea*)	50	5
7	Karanja (*Pongamia pinnata*)	40	7
8	Hijal (*Baringtonia acutangula*)	35	8
Fruit trees			
9	Mango (*Mangifera indica*)	100	1
10	Guava (*Psidium guajava*)	100	1
11	Papaya (*Carica papaya*)	100	1
12	Lemon (*Citrus* spp.)	100	1
13	Bau-kul (*Zizyphus* sp)	85	2
14	Apple-kul (*Zizyphus* sp)	85	2
15	Olive (*Olea europea*)	40	7
16	Hog plam (*Sponolias pinnata*)	35	8
Jamalpur			
Timber trees			
1	Eucalyptus (*Eucalyptus cameldulensis*)	100	1
2	Akashmoni (*Acacia auriculiformis*)	80	2
3	Mahogony (*Swietenia macrophylla*)	100	1
4	Lombu (*Khya* sp.)	65	3
5	Raintree (*Albizia saman*)	45	5
6	Koroi (*Albizia* spp.)	45	5
7	Teak (*Tectona grandis*)	45	5
8	Goraneem (*Melia azedarach*)	45	5
9	Gamar (*Gmelina arborea*)	45	5
Fruit trees			
10	Guava (*Psidium guajava*)	100	1
11	Bau-kul (*Zizyphus* sp)	80	2
12	Papaya (*Carica papaya*)	80	2
13	Mango (*Mangifera indica*)	80	2
14	Lemon (*Citrus* spp.)	65	3
15	Hog plam (*Sponolias pinnata*)	35	6
16	Olive (*Olea europea*)	25	7

Table 10. Farmers Priprity of crops/vegetables species for cultivation

Sl. No.	Species	% farmers possessing	Rank
Mymensingh			
1	Radish (*Raphanus sativus*)	90	1
2	Cucumber (*Cucumis sativus*)	90	1
3	Musturad (*Brssica* spp.)	90	1
4	Red amaranth (*Amaranthus tricolor*)	85	2
5	Chilli (*Capsicum* spp.)	85	2
6	Tomato (*Lycopersicon esculentum*)	95	2
7	Sweet gourd (*Cucurbita moschata*)	85	2
8	Bitter gourd (*Momordica charantia*)	85	2
9	Bottle gourd (*Lagenaria siceraria*)	70	3
10	Indian spinach (*Basella alba*)	70	3
11	Peanut (*Sterculia quadrifida*)	70	3
12	Aroids (*Colocasia alba*)	60	4
Jamalpur			
1	Chilli (*Capsicum* spp.)	75	1
2	Radish (*Raphanus sativus*)	75	1
3	Tomato (*Lycopersicon esculentum*)	65	2
4	Sweet gourd (*Cucurbita moschata*)	65	2
5	Bitter gourd (*Momordica charantia*)	65	2
6	Red amaranth (*Amaranthus tricolor*)	65	2
7	Cucumber (*Cucumis sativus*)	60	3
8	Mustard (*Brssica* spp.)	60	3
9	Aroids (*Colocasia alba*)	35	4

Table 11. Agroforestry practices observed in the char areas of Mymensingh and Jamalpur Districts

Agroforestry system	% farmers possessing	Rank
Eucalyptus-Rice	25	1
Eucalyptus-Okra	15	2
Akashmoni-Brinjal	10	3
Akashmoni-Papaya	8	4
Mahogony-Ginger-Turmeric	5	5

Table 12. Existing species and plant population density in the study area

Location		Species density/100m² area	Plant density/100m² area	Standard deviation
Mymensingh	Kalibari	0.17	0.295	0.018
	Gobadia	0.15	0.278	0.016
	Average	0.16	0.287	
Jamalpur	Ghosherpara	0.14	0.245	0.017
	Topkerchar	0.13	0.257	0.013
	Average	0.135	0.251	

Farmers opinion and preference for combined production of trees and crops as agroforestry system: Farmers of the char areas of Mymensingh and Jamalpur districts opined for both positive and negative attitude on practicing different trees and crops simultaneously on their charland (Fig. 7). Majority (65-70%) of the farmers of Mymensingh region were agreed to accept agroforestry practices while in Jamalpur region only 45-50 % farmers agreed for practicing agroforestry in their charland (Fig. 7). Farmers of these areas also mentioned some specific tree-crop combination separately for winter and summer season which will be suitable in the char areas of Mymensingh and Jamalpur districts (Table 13).

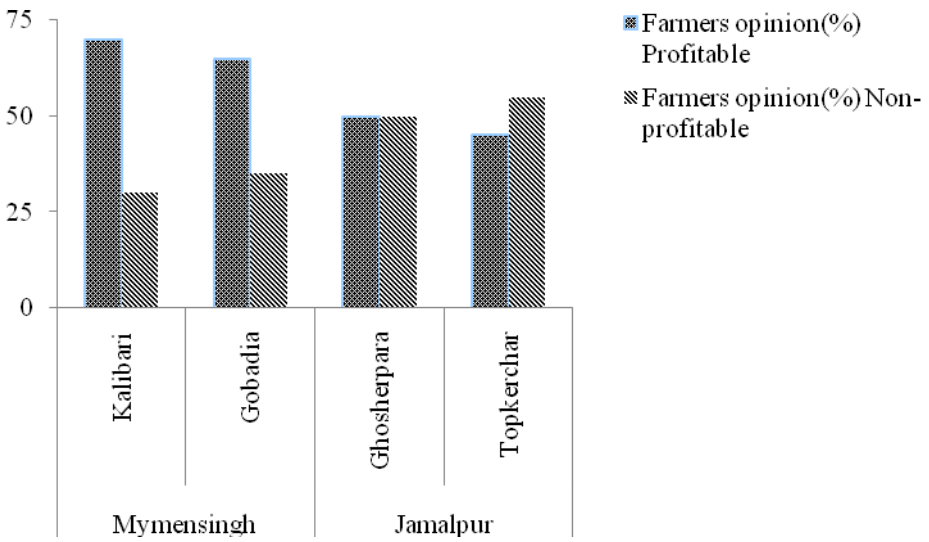

Fig. 7. Farmers opinion (profitable or not) on combined production of trees and agricultural crops

Table 13. Farmers preference of the specific tree -crop/vegetables combination in the char areas of Mymensingh and Jamalpur

Sl. No.	Tree-crop/vegetables combination	Preference of the farmers (%)	Rank
Mymensingh			
Winter season			
1	Akashmoni, Sweet gourd and Mustard	70	1
2	Akashmoni and Bottle gourd	65	2
3	Mahogony, Papaya and Red amaranth	65	2
4	Mahagony and Bottle gourd	57	3
5	Lombu, Sweet gourd and Bitter gourd	50	4
6	Lombu and Tomato	43	5
7	Lombu, Radish and Red amaranth	40	6
8	Eucalyptus and Sweet gourd	35	7
9	Mango, Jujube and Radish	30	8
10	Karanja, Mehogoni and Bitter gourd	22	9
11	Guava, Lemon and Mustard	16	10
Summer season			
12	Akashmoni and Kangkong	70	1
13	Lombu and Indian spinach	65	2
14	Lombu and Okra	60	3
15	Mango, Papaya and Amaranth	55	4
16	Guava and Okra	52	5
17	Mango and Amaranth	45	6
18	Hijal and Kangkong	40	7
19	Mahogony and Okra	30	8
20	Karanja and Kangkong	30	8
21	Lemon and Okra	25	9
22	Jujube, Guava and Okra	22	10
23	Guava and Jute (as vegetable)	15	11
Jamalpur			
Winter season			
1	Eucalyptus and Rice	70	1
2	Eucalyptus and Chilli	65	2
3	Akashmoni and Rice	60	3
4	Akasmoni and Chilli	55	4
5	Eucalyptus, Chill and Radish	50	5
6	Eucalyptus, Brinjal and Red amaranth	45	6
7	Eucalyptus. Chilli and Seasame	40	7
8	Akashmoni, Radish and Amaranth	35	8
Summer season			
9	Eucalyptus and Rice	70	1
10	Akshmoni and Rice	65	2
11	Eucalyptus and Jute (as vegetable or crop)	60	3
12	Akasmoni and Jute (as vegetable or crop)	55	4

Livelihood improvement parameters

Livelihood status of the farmers in the study area will be evaluated based on some parameters. These are productivity, income, nutrition, resource pattern, technical knowledge, employment generation, market linkage and women participation. Existing status of these parameters was critically observed in the study areas. It was found that peoples of the study areas have no idea about innovative technology, intensive cropping pattern, specific agroforestry model and training activities related to agroforestry and other production systems (Table 14). But peoples of Mymensingh and Jamalpur char areas have little awareness about modern varieties of crops/vegetables. Rural youth and children were involved in the agricultural activities.

Involvement of children in the agricultural activities was more in Jamalpur than Mymensingh areas (Table 14). Most of the peoples of both areas used their own labour in the agricultural and agroforestry activities and a few peoples hired some labour for the same activities. Women's of both Mymensingh and Jamalpur are mainly engaged in the homestead activities, some participate for plantation purpose and a very few are involved with marketing activities. Most of the products of these char areas of Mymensingh and Jamalpur sale in the local market and some portion also sale in the Thana sadar or City market (Table 14). 20-40% people exchange their view with other persons or organizations.

Table 14. Livelihood improvement parameters (System sustainability) in the research areas

Sl. No.	Area of consideration	(Probable) Indicators to assess the sustainability	% farmers adopting/ utilizing the technologies			
			Mymensingh		Jamalpur	
			Kalibari	Gobadia	Gosherpara	Topkerchar
1	Productivity	Use of alternative option	5	0	0	0
		Innovative technologies	5	0	0	0
		Use of enhanced skill and knowledge	20	15	10	10
		Sharing of knowledge	10	5	0	0
2	Income	Use of modern varieties	25	20	15	15
		Innovative technologies	10	5	5	5
		Use more area under cultivation/production	10	5	5	0
		Increased production skill due to training	10	5	5	0
		Spot demonstration	10	5	5	0
3	Nutrition based on productivity (if any)	Consumption of vegetables, fruits increased	20	15	10	10
		Changed in consumption habit towards vegetables and Fruits	5	5	0	0
		Reduced no. of disease and frequency of attack	0	0	0	0
		Good appearance of family members	15	10	5	5
4	Resource pattern	Fuel wood production	10	5	5	5
		Used in homestead	5	0	0	0
		Intensive cropping pattern	0	0	0	0
		Introduction of homestead production models	5	0	0	0
5	Technical Knowledge	Young girls and boys are engaged for implementation of new technologies	20	40	50	45
		Training, field days, exchange of views with different type of people	40	30	25	20
6	Employment generation	Use of unutilized family labour	50	45	55	40
		Women participation in Agril. activities (85%)	10	15	25	25
		Huge hired labour used in Agro-forestry system and created employment	25	15	10	10
7	Market Linkage	Market linkage of the products	35	30	15	10
		Farmers directly sold their farm products to the traders with reasonable price	0	0	0	0
8	Woman participation increased	Homestead	50	65	75	80
		Tree plantation and nursery	10	15	25	25
		Marketing	5	5	0	0

Environmental parameters

Environmental situation of the study area was measured based on biodiversity, soil quality, agrochemicals and pollution status. Existing situation of these parameters are presented in table 15.

Table 15. Existing situation of Environmental parameter in the char areas of Mymensingh and Jamalpur

Sl. No.	Environmental issue	Component	Baseline/ before (%)*	Degree of Impact				Remarks
				Small (<20%)	Moderate (20-50%)	Large (>50%)	None	
1	Biodiversity	Flora	60%			√		
		Fauna	20%		√			
		Genetic diversity	35%		√			
		Exotic varieties	10%	√				
		Local varieties/ cultivars	75%			√		
		Hybrids	15%	√				
2	Soil quality	Organic matter	40%		√			
		Chemical fertilizer use	25%		√			
		Soil salinity	0%				√	
		Fertility status	35%		√			
		Microbial activity	40%		√			
		Heavy metal contamination	0%				√	
		Water quality	50%		√			
3	Agro-Chemicals	Pesticide use	25%		√			
		POPs	0%				√	
		IPM	30%		√			
		Pest infestation	15%	√				
		Bio-pesticides	50%		√			
		Health hazard	0%				√	
4	Pollution	Soil	0%				√	
		Water	0%				√	
		Air	0%				√	

* % of each component was determined considering the optimum value as 100.

Linkage between agroforestry activities and farmers characteristics

In the present study some correlations/linkages were made between agroforestry activities and farmers characteristics separately for char areas of Mymensingh and Jamalpur (Table 16). Farmers characteristics were age, education, family size, occupation, farm size, homestead size, fallowland size, charland size and annual income. Among the nine characteristics of farmers six were significantly correlated with agroforestry activities as 1% or 5% level of probability and these were education, occupation, farm size, homestead size, fallowland size, and annual income. Others three characteristics had no relationship with the agroforestry activities in char areas of Mymensingh and Jamalpur (Table 16). Among correlated six characteristics education plays a vital role for practicing agroforestry in the char areas. Only educated person can realize the significance of agroforestry for maintaining environmental stability and ecological balance. It was found that in both char areas with increasing education level agroforestry activities as well integrated approach of crops with trees also increased (Fig. 8).

Table 16. Correlation between agroforestry activities and independent variables in Mymensigh and Jamalpur

Independent variables	r' value		level of significance	
	Mymensingh	Jamalpur	Mymensingh	Jamalpur
Age	0.018	0.012	NS	NS
Education	0.322	0.313	*	*
Family size	0.023	0.035	NS	NS
Occupation	0.217	0.284	**	**
Farm size	0.261	0.281	**	**
Homestead size	0.345	0.308	*	*
Fallow land size	0.392	0.319	*	*
Charland size	0.016	0.037	NS	NS
Annual income	0.291	0.211	**	**

*, **-indicated significant at 5 and 1% level of significance; NS-nonsignificant.

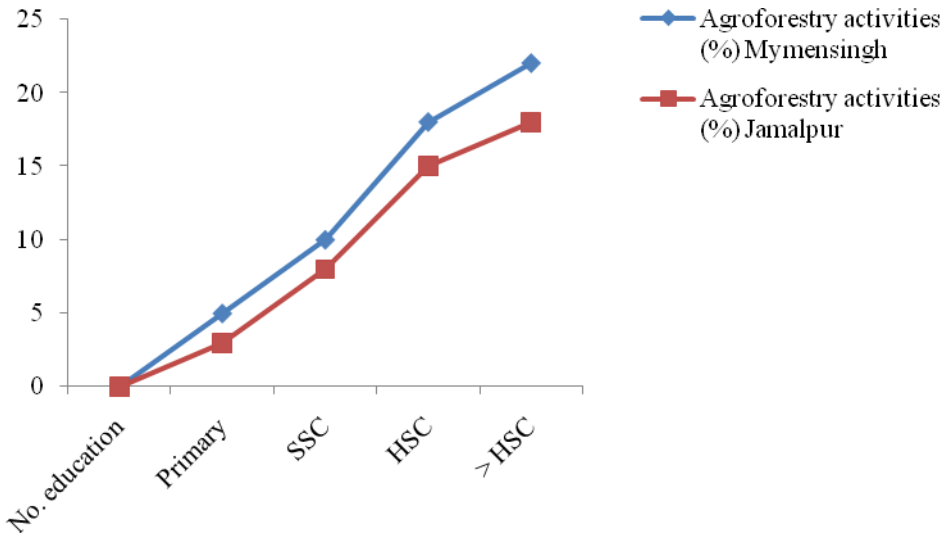

Fig. 8. Relationship between agroforestry activities and education level of the farmers of Mymensingh and Jamalpur char areas

Problem regarding tree plantation

1. High price of fertilizer & pesticide
2. High price of crop seed
3. High labour cost
4. Unavailability of seedling
5. Lack of capital for investment in farming
6. Lack of proper knowledge about tree plantation
7. Lack of awareness for plantation of trees
8. Lack of sufficient cultivated area of land
9. Lack of sufficient homestead area for plantation
10. Environmental hazards such as flood, drought, cyclone etc. cause damage to the seedling

Probable solution of the above problem

1 Reduce price of fertilizer, pesticide and seed

2 Availability of seedling should be ensured

3 Provide technical help regarding plantation and management of trees and crops

It appears from the benchmark survey that the farmers are cultivating crops/vegetables in the char areas. But there were no definite agroforestry practices. Therefore, there are scopes to develop agroforestry based production systems which will be more income generating and environment friendly. Socio-economic condition of the selected farmers recorded during the benchmark survey will be used as primary indicators for evaluating the success or failure of the project.

10.2 Present status of selected farmers

After finishing the benchmark survey, 19 (nineteen) farmers were selected of which 10 (ten) from Mymensingh and 9 (nine) from Jamalpur for introducing new agroforestry practices as well as improvement of existing one. Age, education level, family size, farm size, knowledge of trees, agroforestry, livelihood and environment, annual income, number of tree species per family, tree species density, tree population density, existing agroforestry system, etc., of the selected farmers were observed for evaluation purpose of the project. After completion of the project period, knowledge about trees, agroforestry, livelihood and environment, annual income, tree species density, tree population density, etc., will be the evaluating indicator of the project. The positive changes of these parameters will be the success of this coordinated project. Present status of the selected farmers regarding the above mentioned parameters are presented in the table 17. Knowledge about trees, agroforestry and environment of the selected farmers of the study area

was not satisfactory. Average annual income of the selected farmers in Mymensingh and Jamalpur was 43,700/- and 31,150/- Tk. Tree species density means, total number tree species in unit area and tree population density means, total number of trees in all species in unit area. Average tree species density and tree population density of the selected farmers of Mymensingh and Jamalpur districts were 0.185 and 0.180, 0.383 and 0.382 per $100m^2$ land area (Table 17). Annual income, tree species density and tree population of these char area was very low i.e., not sufficient for friendly environment, better livelihood and ecological balance. There is no scope for improving the existing agroforestry systems/practices because a very few such system was found in these char areas. So, it is better to develop or introduce new agroforestry system/practices in these char areas.

Table 17. Existing status of selected farmers of the Char areaa of Mymensingh and Jamalpur district

Characteristics	Location								Std. deviation
	Mymensingh				Jamalpur				
	Char Kalibari		Char Gobadia		Char Gosherpara		Topkerchar		
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
Age (years)	44	30-55	56	50-67	51	30-75	45	30-60	13.63
Education level	3.5	0-10	2.1	0-6	2.3	0-8	1.9	0-5	0.85
Family size (No.)	5.67	3.0-10.0	7	4.0-10.0	5	3.0-7.0	4.25	3.0-6.0	1.59
Farm size (ha)	0.88	0.56-1.5	0.65	0.24-0.84	0.72	0.34-0.9	0.38	0.14-0.75	0.34
Annaul income (Tk.)	45300	35000-85000	42100	30000-80000	33800	28000-75000	28500	25000-70000	11310.5
Knowledge about tree (Score out of 50)	18	10.0-25.0	13	10.0-18.0	15	10.0-20.0	10	10.0-17.0	3.547
Knowledge about agroforestry (Score out of 50)	10	5.0-15.0	7	5.0-11.0	8	5.0-13.0	6	5.0-10.0	2.785
Knowledge about environment (Score out of 50)	9	5.0-14.0	6	5.0-10.0	7	5.0-12.0	5	5.0-9.0	1.649
Number of species /farmer	17	14-18	12	10.0-15.0	14	12.0-16.0	10	8.0-13.0	1.41
Number of trees /farmer	35	25-45	24	18-30	28	22-35	21	15-28	2.54
Tree density/100 m^2 area	0.397	0.33-0.48	0.369	0.26-0.42	0.388	0.29-0.44	0.375	0.25-0.45	0.018
Species density/100 m^2 area	0.19	0.12-0.28	0.18	0.11-0.26	0.19	0.12-0.29	0.17	0.11-0.25	0.011
No. of existing agroforestry system	0.22	0-2	0	0	0.23	0-2	0	0	0.012

Farmers income from selected plots

Before the execution of SPGR sub-project, in total 20 plots of twenty different farmers were selected and income received from these plots were also recorded during the benchmark survey. It was found that some plots remained fallow and some generated few income which were not satisfactory (Tables 18a & 18b). All these information were used as indicators for evaluating the success/failure at the end of the project period.

Table 18a. Farmers income from the selected plots before project implementation in the char areas of Mymensingh

Name of the farmers	Land area (ha)	Total income (Tk.)		
		Winter	Summer	Total
Hamid Fakir	0.68	15000	Fallow	15000
Yunus Ali	0.25	Fallow	Fallow	0
Liakot Miah	0.19	Fallow	Fallow	0
Mohosin	0.13	Fallow	Fallow	0
Hafiz Uddin	0.19	500	Fallow	500
Md. Tara Miah	0.18	Fallow	Fallow	0
Liton	0.09	2500	Fallow	2500
Shaheb Ali	0.07	Fallow	Fallow	0
Tota Miah	0.08	Fallow	Fallow	0
Liakot Ali	0.19	Fallow	Fallow	0

Table 18b. Farmers income from the selected plots before project implementation in the char areas of Jamalpur

Name of the farmers	Land area (ha)	Total income (Tk.)		
		Winter	Summer	Total
Muktel Hossen	0.152	1000	500	1500
Boshir Uddin	0.096	800	Fallow	800
Shahaj	0.102	1050	750	1800
Nazrul Islam	0.074	Fallow	Fallow	0
Hanif Uddin	0.064	950	1250	2200
Robiul Islam	0.083	2500	Fallow	2500
Zohurul Islam	0.075	1600	500	2100
Monzurul Islam	0.076	2300	Fallow	2300
Foej Uddin	0.065	1600	Fallow	1600

10. 3 Tree saplings transplantation

For introducing new agroforestry system/practices, first requirement is transplanting of tree saplings. For this purpose, 2811 tree saplings were planted of which 2240 in Mymensinh and 571 in Jamalpur in the year 2011. These saplings were planted on 2.65 ha areas of which 1.86 ha are in Mymensingh and 0.787 ha in Jamalpur (Table 19a). Total 11 (eleven) different species were planted in these areas, viz., akashmoni (*Acacia auriculiformis*), eucalyptus (*Eucalyptus camaldulensis*), mahogony (*Swietenia macrophylla*), lombu (*Khya* sp.), karanja (*Pongamia pinnata*), mango (*Mangifera indica*), muava (*Psidium guajava*), lemon (*Citrus* spp.), jujube (*Zizyphus* spp.), olive (*Olea europea*) and papaya (*Carica papaya*). Almost more than 70 % saplings of these species are already established in the char areas of Mymensingh and Jamalpur district (Table 19a).

Initially people were not interested to plant tree sapling in their own land but after one year of project execution more people became interested for plantation. Now people are slowly realizing the significance of agroforestry, as a results they want to get involvd in the agroforestry activities. For this reason more tree saplings were planted in the newly selected farmers plots. Total 5075

different tree saplings were planted on 4.2 ha of land of which 4475 are in Mymensingh and 1600 in Jamalpur (Table 19b).

Table 19a. Tree seedling plantation on the selected farmers field in Mymensingh and Jamalpur district during the year 2011

District	Char	Name of farmers	Tree species					Area planted (ha)
			Name of species	Planted	Established	Died	% established	
Mymensingh	Kalibari	Hameed Fakir	Koronja	98	70	28	71	0.68
			Lombu	70	50	20	71	
			Mehogony	105	83	22	79	
			Akashmoni	250	232	18	93	
			Eucalyptus	30	12	18	40	
			Mango	50	42	8	84	
			Lemon	30	24	6	80	
			Guava	30	24	6	80	
			Jujube	30	15	15	50	
			Papaya	270	190	80	70	
		Yunus Ali	Eucalyptus	60	40	20	67	0.25
			Lombu	44	30	14	69	
			Lemon	30	24	6	80	
			Papaya	48	32	16	67	
			Guava	28	20	8	72	
		Liakot Miah	Akashmoni	50	42	8	84	0.19
			Mahogony	35	25	7	71	
		Mohosin	Akashmoni	62	45	17	73	0.13
			Mango	20	16	4	80	
			Jujube	16	10	6	63	
			Lemon	12	11	1	99	
			Papaya	52	38	14	73	
		Hafiz Uddin	Mango	22	21	1	98	0.19
			Jujube	40	18	22	45	
			Lemon	22	21	1	99	
			Papaya	96	70	26	73	
		Md. Tara Miah	Akashmoni	30	22	8	73	0.18
			Mehogony	130	112	18	86	
			Mango	15	13	2	87	
			Jujube	18	15	3	84	
			Lemon	21	20	1	96	
			Papaya	140	102	38	72	
		Md. Liton Miah	Akashmoni	48	32	16	66	0.09
			Lombu	50	30	20	60	
	Gobadia	Shaheb Ali	Mahogony	55	38	17	69	0.07
		Tota Miah	Akashmoni	50	38	12	76	0.08
		Liakot ali	Lombu	30	18	12	60	0.19
			Eucalyptus	25	16	9	64	
			Olive	16	12	4	75	
			Papaya	12	5	7	45	
			Total	2240	1626	614		2.05
Jamalpur	Gosherpara	Muktel Hossen	Akashmoni	100	78	22	78	0.152
		Boshir Uddin	Eucalyptus	52	32	20	61	0.096
		Shahaj Uddin	Eucalyptus	41	25	16	61	0.102
		Nazrul Islam	Akashmoni	32	25	7	78	0.074
		Hanif Uddin	Eucalyptus	30	20	10	67	0.064
	Topkerchar	Robiul Islam	Akashmoni	95	78	17	82	0.083
			Eucalyptus	85	61	24	71	
		Zohurul Islam	Eucalyptus	54	49	5	90	0.075
		Monzurul Islam	Eucalyptus	38	28	10	74	0.076
		Foej Uddin	Eucalyptus	44	36	8	81	0.065
			Total	571	432	139		0.787
Grand Total				2811	2058	753		2.84

Table 19b. New tree seedling plantation on the selected farmers field in Mymensingh and Jamalpur district in the year 2012

Location	Name of farmers	Tree species		Area planted (ha)
		Name of species	Planted	
Mymensingh	Fakaruddin	Lambu	750	1.25
		Akashmoni	750	
		Mahogoni	750	
	Gafur	Guava	500	0.5
		Lombu	500	
		Mahogoni	250	
	Zabbar Mia	Akashmoni	200	0.25
		Mangium	200	
	Hamid Fakir	Hijal	75	0.12
	Shahidul Islam	Akashmoni	50	0.22
		Eucalyptus	50	
		Mango	20	
		Papaya	20	
	Abul Kalam	Mahogoni	50	0.21
		Lombu	50	
		BAU-kul	20	
		Guava	20	
	Shahed Ali	Akashmoni	40	0.14
		Eucalyptus	40	
		BAU-kul	10	
		Guava	10	
	Md. Mofajjol	Mahogoni	40	0.18
		Lombu	40	
		Mango	20	
		Papaya	20	
	Total		4475	2.98
Jamalpur	Litu Mia	Eukalyptus	400	0.48
		Akashmoni	200	
	Mukhlesur Rahman	Eukalyptus	400	0.49
		Akashmoni	250	
	Md. Raihan	Eukalyptus	350	0.25
	Total		1600	1.22
Grand Total			5075	4.2

10.4 Vegetables/crops cultivation in association with planted tree saplings

Different vegetables/crops were cultivated both in winter and summer season along with the planted tree saplings. In five seasons vegetables/crops were cultivated, viz., winter 2011, summer 2012, winter 2012, summer 2013 and winter 2013. In this chapter results obtained from winter 2011, summer 2012, winter 2012, summer 2013 and winter 2013 are presented as follows:

Winter 2011: During winter 2011 different vegetables/crops were cultivated with different timber and fruit species separately to observe the (i) Performance of vegetables/crops in association with different timber trees, (ii) Performance of vegetables/crops in association with different fruit trees.

(i) Performance of vegetables/crops in association with different timber trees

Five timber species, viz., akashmoni (*Acacia auriculiformis*), eucalyptus (*Eucalyptus camaldulensis*), mahogony (*Swietenia macrophylla*), lombu (*Khya* sp.) and karanja (*Pongamia pinnata*) were planted in the selected farmers plots. Various vegetables/crops were cultivated in

association with these timber trees. Vegetables/crops were sweet gourd, bottle gourd, bitter gourd, radish, tomato, chilli, sesame, rice, mungbean, mustard, etc. (Fig. 9). Sweet gourd was cultivated with akashmoni, eucalyptus, mahogony, lombu and karanja. Yield of sweet gourd was similar with all tree species and yield ranges from 34.5 tha^{-1} (with mahogony) to 36.5 tha^{-1} (with akashmoni). Bottle gourd was cultivated with akshmoni, mahogony and lombu. Yield of bottle gourd was similar with all tree species and yield ranges from 39.1 tha^{-1} (with mahogony) to 41.2 tha^{-1} (with akashmoni). Bitter gourd was cultivated with mahogony, lombu and karanja. Yield of bitter gourd was similar with all tree species and yield ranges from 8.7 tha^{-1} (with mahogony) to 9.3 tha^{-1} (with karanja). Radish was cultivated with akashmoni and eucalyptus. Yield of radish with akshmoni was 44.1 tha^{-1} and with eucalyptus 43.8 tha^{-1}. Yield of tomato was 22 tha^{-1} with lombu. Mustard was cultivated as vegetable with akashmoni (3.9 tha^{-1}) and eucalyptus (3.7 tha^{-1}), it was also cultivated for seed production purpose with euclyptus (1.6 tha^{-1}). Chilli and rice were cultivated with akashmoni and euclyptus and the yield was 2.08 & 2.03 and 1.71 & 1.68 tha^{-1}. Sesame was cultivated only with eucalyptus (0.55 tha^{-1}) and mungbean only mahogony (1.5 tha^{-1}). The yield obtained from these plots were compared with the yield obtained from farmers/ others plots, i.e., without trees (Table 20). During the early establishment period (first year of plantation) yield of all cultivated vegetables/crops were almost similar with yield of the respective vegetables/crops cultivated without tree association (Table 20). These results indicate that during the early establishment period of timber and fruit trees vegetables/crops can be successfully cultivated without significant yield loss.

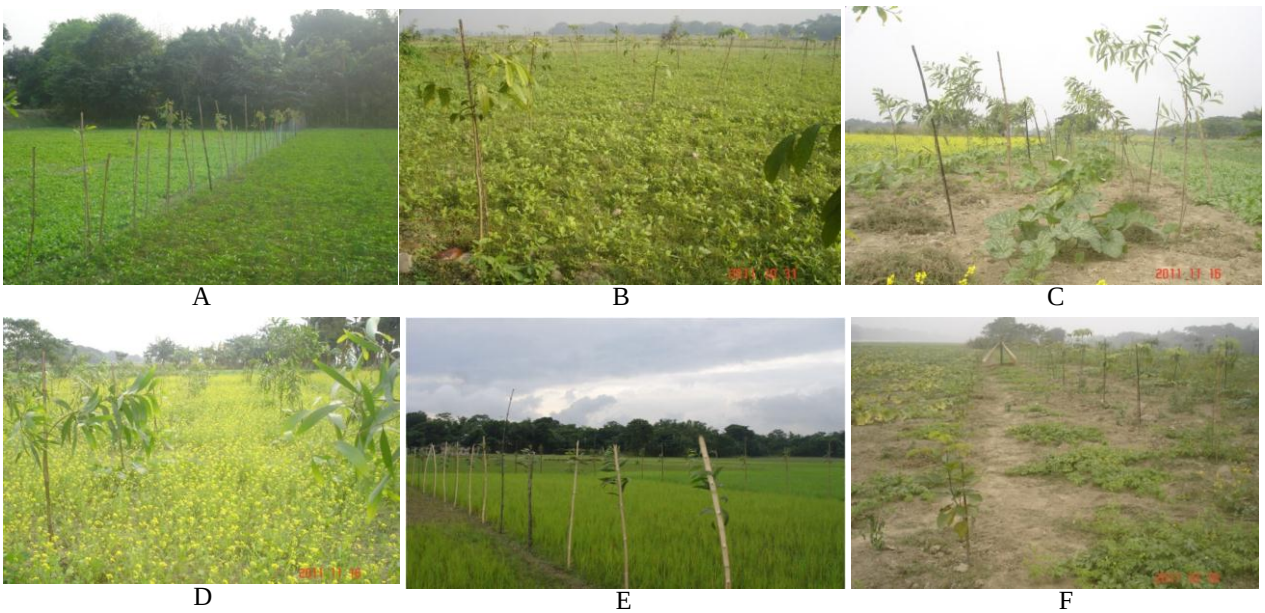

Fig. 9. Winter vegetables under different timber tree sapling (A) Eucalyptus-Mustard-Chilli, (B) Lombu-Mungbean, (C) Akashmoni-Sweetgourd, (D) Akshmoni-Mustard, (E) Eucalyptus-Rice, and (F) Karanja-Mahogany-Bittergourd

Table 20. Yield performance of different winter vegetables/crops with timber trees

Tress species	Crops	Yield (ton/ha)		Price (Tk./Kg)
		With trees	Without trees (control)	
Akashmoni	Chilli	2.08	2.06	40
	Rice	1.71	1.73	15
	Bottle gourd	41.2	42.2	10
	Mustard (shak)	3.9	4.3	15
	Sweet gourd	36.5	36.8	8
	Radish	44.1	45.5	5
Eucalyptus	Chilli	2.03	2.08	40
	Rice	1.68	1.69	15
	Sweet gourd	35.9	36.8	8
	Mustard (seed)	1.6	1.8	45
	Mustard (shak)	3.7	4.3	15
	Radish	43.8	45.5	5
	Seasame	0.55	0.58	50
Mahogony	Sweet gourd	34.5	36.8	8
	Bottle gourd	39.1	42.2	10
	Bitter gourd	8.7	9.5	40
	Mungbean	1.5	1.6	60
Lombu	Sweet gourd	35.9	36.8	8
	Bottle gourd	40.8	42.2	10
	Tomato	22	23	10
	Bitter gourd	9.1	9.5	40
Karanja	Sweet gourd	36.3	36.8	8
	Bitter gourd	9.3	9.5	40

(ii) Performance of vegetables/crops in association with different fruit trees

Four fruit tree species, viz., mango (*Mangifera indica*), guava (*Psidium guajava*), lemon (*Citrus* spp.), and jujube (*Zizyphus* spp.) were planted in the selected farmers plots. Various vegetables/crops were cultivated in association with these fruit trees (Fig.10). Vegetables/crops were sweet gourd, bottle gourd, bitter gourd, radish, tomato, red amaranth, jute shak and mustard, etc. Sweet gourd was cultivated with mango and lemon. Yield of sweet gourd was similar with these tree species and yield was 35.3 tha^{-1} (with mango) and 36.1 tha^{-1} (with lemon). Bottle gourd was cultivated with mango and jujube. Yield of bottle gourd was 40.3 tha^{-1} (with mango) and 40.7 tha^{-1} (with jujube). Bitter gourd was cultivated with mango and yield of bitter gourd was 8.5 tha^{-1}. Radish was cultivated with mango, jujube and lemon. Yield of Radish was similar with all fruit tree species and yield ranges from 43.8 tha^{-1} (with jujube) to 46.2 tha^{-1} (with mango). Yield of tomato with guava was 24 tha^{-1}. Yield of red amaranth was ranges from 7.7 tha^{-1} (with guava) to 8.3 tha^{-1} (with jujube). Mustard was cultivated as vegetable with lemon (4.1 tha^{-1}), it was also cultivated for seed production purpose with lemon (1.9 tha^{-1}). The yield obtained from these plots were compared with the yield obtained from farmers/ others plots, i.e., without trees (Table 21). During early establishment period (first year of plantation) yield of all cultivated vegetables/crops were almost similar with yield of the respective vegetables/crops cultivated without tree

association (Table 21). These results indicate that during early establishment period of the fruit trees vegetables/crops can be successfully cultivated without significant yield loss.

A B C D

Fig. 10. Winter vegetables different fruit tree sapling (A) Mango-Mustard-Sweetgourd, (B) Guava-Lemon-Jujube-Mustard-Sweetgourd, (C) Mango-Mustard shak, (D) Mango-Jute shak.

Table 21. Yield performance of different winter vegetables/crops with fruit trees

Tress species	Crops	Yield (ton/ha)		Price (Tk./Kg)
		With trees	Without trees (control)	
Mango	Red amaranth	7.9	8.6	8
	Coriander	3.6	3.7	60
	Sweet gourd	35.3	36.8	8
	Bitter gourd	8.5	9.5	40
	Bottle gourd	40.3	42.2	10
	Radish	46.2	45.5	5
Guava	Tomato	24	23	10
	Red amaranth	7.7	8.6	8
Jujube	Bottle gourd	40.7	42.2	10
	Radish	43.8	45.5	5
	Red amaranth	8.3	8.6	8
	Coriander	3.8	3.7	60
Lemon	Sweet gourd	36.1	36.8	8
	Mustard (seed)	1.9	1.8	45
	Mustard (shak)	4.1	4.3	15
	Coriander	3.6	3.7	60
	Radish	44.3	45.5	5

Summer 2012: Four summer vegetables, viz., amaranth, kangkong, okra and indian spinach were cultivated with different trees. Results from this study were as follows:

Morphological characteristics of summer vegetables

Kangkong: Morphological parameters of kangkong like length of twig, twig per plant, leaves per plant and stem girth were significantly variable in association with different trees (Table 22, Fig. 11c). Longest twig (38.5cm) was observed in association with hijal trees which was statistically similar with the twig length (37.3cm) of kangkong recorded along with karanja trees. Statistically similar size twig was observed along with akashmoni, mahogoni, lombu, mango, lemon and jujube. Lowest size twig was found in association with guava and control condition, i.e., without trees. Shortest size twig was recorded along with eucalyptus (27.9 cm) and papaya (28.8cm). Highest number of twig per plant was found in control condition (12.8) which was statistically similar with the number of twig per plant in association with mahogoni (12.1), lambu (12.2), mango (12.2) and guava (11.8). Second highest number of twig per plant was recorded along with akashmoni (10.7) followed by lemon (8.5) and jujube (8.3). Least number of twigs was harvested in association with Papaya (6.1) which was statistically similar to eucalyptus (6.5), hijal (6.8) and karanja (7.1). Like twig plant^{-1}, similar trend of variation was recorded in case of leaves plant^{-1}, where highest (335.5) leaves plant^{-1} were found in case of without tree condition and lowest along with hijal (223.5, Table 22). Highest stem girth (2.91cm) of kangkong was found in case of without tree condition and among the tree association this value was highest along with lombu (2.83cm) which was gradually decreased in association with mahogoni

(2.77cm), mango (2.73cm), guava (2.71cm), jujube (2.62cm), lemon (2.61cm), akashmoni (2.43cm), eucalyptus (2.41cm), papaya (2.35cm), karanja (2.15cm) and hijal (2.13cm).

Indian spinach: Like kangkong, all morphological parameters of Indian spinach viz. length of twig, twig per plant, leaves per plant and stem girth were significantly different in combination with different trees (Table 22, Fig. 11). Longest twig (50.7cm) was observed in association with hijal trees which is statistically similar with the twig length (49.3cm) of kangkong recorded along with karanja trees. Statistically similar size twig was observed along with mahogony, lombu, mango, lemon, jujube and guava which was second highest. Third highest size twig was found in association with akashmoni and control condition, i.e., without trees. Shortest size twig was recorded along with eucalyptus (37.6cm) and papaya (37.8cm). Highest number of twig per plant was found in control condition (8.5) which was statistically similar with guava (7.7). Twigs plant^{-1} of Indian spinach is simelar in combination with akashmoni, mahogony, lombu, mango, lemon and jujube were 5.5, 6.9, 7.4, 7.2, 5.1 and 5.3. Least number of twigs was harvested in association with hijal (4.1) which was statistically similar with eucalyptus (4.6), papaya (4.7) and karanja (4.5). Like twig plant^{-1}, similar trend of variation was recorded in case of leaves plant^{-1}, where highest (235.5) leaves plant^{-1} were found without tree condition and lowest along with hijal (178.5, Table 22). Highest stem girth (3.7cm) of kangkong was found without tree condition and among the tree association this value was highest along with mahogoni (3.6cm) which was gradually decreased in association with lambu (3.5cm), mango (3.5cm), guava (3.5cm), akashmoni (3.3cm), lemon (3.2cm), jujube (3.2cm), eucalyptus (2.8cm), papaya (2.8cm), karanja (2.1cm) and hijal (2.1cm).

Table 22. Morphological Characteristics of summer vegetables in association with different tree species

	Tree species	Morphological Characteristics of summer vegetables															
		Kangkong				Indian spinach					Amaranth			Okra			
		Length twig^{-1} (cm)	Branches plant^{-1}	Leaves plant^{-1}	Stem girth (cm)	Length twig^{-1} (cm)	Branches plant^{-1}	Leaves plant^{-1}	Stem girth (cm)	Plant height (cm)	Leaves plant^{-1}	Stem girth (cm)	Weight plant^{-1} (g)	Plant height (cm)	Leaves plant^{-1}	Fruit length (cm)	Fruit girth (cm)
Timber trees	1. Akashmoni	33.5b	10.7b	298.5b	2.43c	41.6c	5.5bc	210.5bc	3.3bc	87.4b	24.4c	7.3b	152.5b	103.4b	56.8b	14.5b	5.3b
	2. Mahogony	31.8bc	12.1a	317.5ab	2.77b	43.1b	6.9b	227.5a	3.6a	91.7a	28.7b	8.5a	179.0a	114.8a	65.3a	17.5a	6.5a
	3. Lombu	31.5bc	12.3a	318.5ab	2.83b	43.3b	7.4b	231.4a	3.5a	90.6a	28.6b	8.8a	179.9a	114.2a	65.9a	17.9a	6.4a
	4. Eucalyptus	27.9d	6.5d	255.5c	2.41c	37.6c	4.6c	201.2c	2.8c	81.8c	20.4d	6.7c	143.6c	92.5c	45.7c	11.5c	4.1c
Fruit trees	5. Mango	31.7bc	12.2a	305.5b	2.73b	43.7b	7.2b	228.5a	3.5a	92.1a	29.2b	8.2ab	178.8a	113.8a	66.5a	17.3a	6.6a
	6. Lemon	32.9b	8.5c	307.5b	2.61b	44.1b	5.1bc	201.7b	3.2b	84.4b	23.4c	7.5b	152.0b	105.2b	53.3b	14.6b	5.1b
	7. Jujube	33.5b	8.3c	311.5b	2.62b	44.3b	5.3bc	203.4b	3.2b	85.4b	23.7c	7.7b	155.0b	104.5b	52.8b	14.9b	5.0b
	8. Papaya	28.8d	6.1d	257.5c	2.35c	37.8d	4.7c	197.1c	2.8c	82.3c	20.1d	6.3c	141.0c	93.6c	43.3c	11.1c	4.3c
	9. Guava	31.2c	11.8a	304.5b	2.71b	43.7b	7.7ab	219.3b	3.5a	92.2a	29.3a	8.2ab	178.5a	114.8a	65.7ab	17.1a	6.6a
soil conserving tress	10. Hijal	38.5a	6.8d	223.5d	2.13d	50.7a	4.1c	178.5d	2.1d	_	_	_	_	_	_	_	_
	11. Karanja	37.3a	7.1d	233.d	2.15d	49.3a	4.5c	183.2d	2.1d	72.3d	19.8d	5.6d	125.1d	83.6d	36.3d	10.2d	3.9c
Without trees		30.5c	12.8a	335.5a	2.91a	40.5c	8.5a	235.5a	3.7a	90.5a	31.1a	9.2a	185.5a	112.5a	68.4a	18.1a	7.1a

Means in column followed by the different letter are significantly different by DMRT at P ≤ 0.05

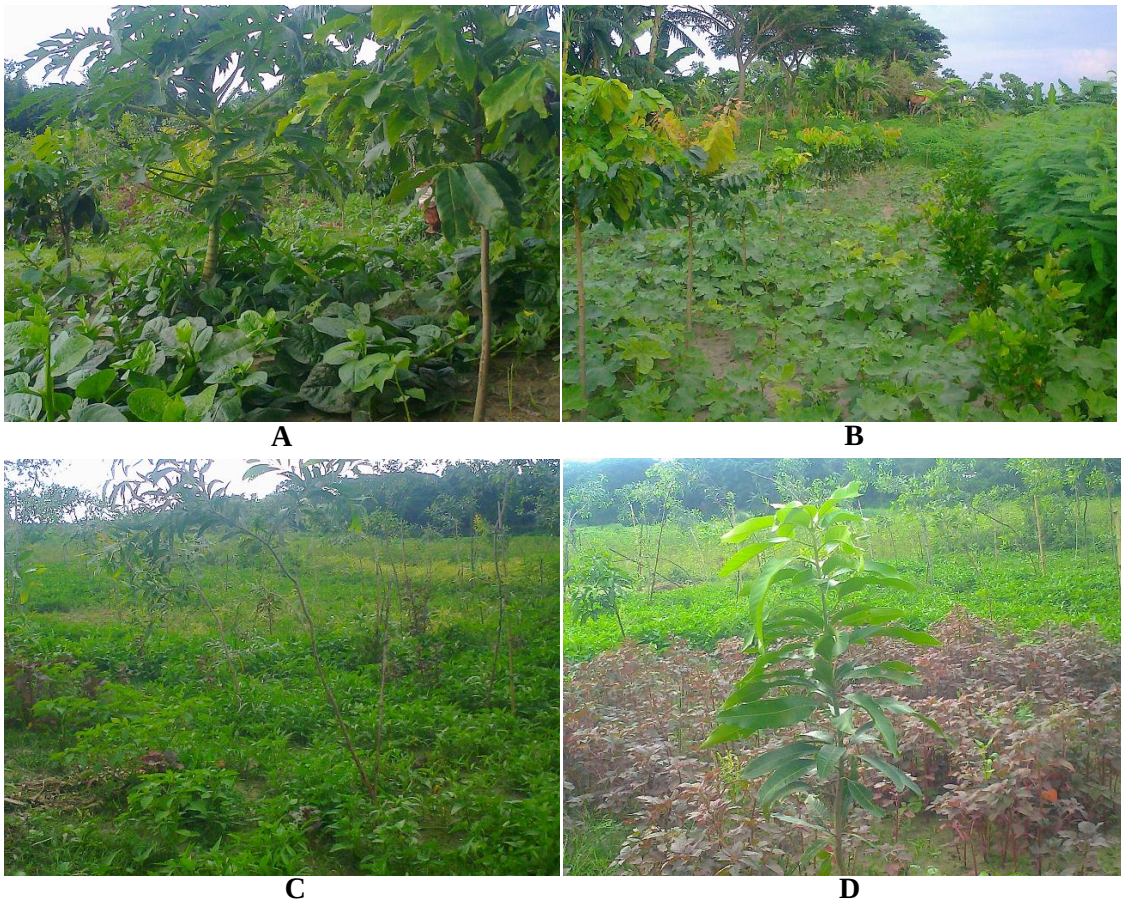

Fig. 11. Summer vegetables along with trees, (A) Indian Spinach, (B) Okra, (C) Kangkong, and (D) Amaranth

Amaranth: Morphological features like plant height, leaves plant^{-1}, stem girth and weight plant^{-1} were significantly influenced by different combination along with different trees (Table 22, Fig. 11d). Tallest plant (90.5 cm) was found in without tree association which was statistically similar with plant height produced along with mahogony (91.7cm), lombu (90.6cm), mango (92.1cm) and guava (92.2cm). Statistically similar size plant was produced in association with akashmoni (87.4cm), lemon (84.4cm), and jujube (85.4cm). Plant height in association with eucalyptus (81.8cm) and papaya (82.3cm) was almost similar as third highest. Shortest plant was found in association with karanja tree (72.3cm). Leaves plant^{-1}, varied like the pattern of plant height where highest leaves plant^{-1} were obtained in control condition (31.1) and lowest (19.8) in association with karanja tree. Stem girth also varied in same pattern where highest stem girth (9.2cm) was recorded under control condition and lowest (5.6cm) in association with karanja tree. Weight plant^{-1} was highest in control condition (185.5g) which was statistically similar with weight plant^{-1} produced along with mahogony (179.0g), lombu (179.9g), mango (178.8g) and guava (178.5g). Statistically similar weight plant^{-1} of amaranth was found combined with akashmoni (152.5g), lemon (152.0g), and jujube (155.0.g) which recorded second highest value. Third highest weight plant^{-1} was found in association with eucalyptus (143.6g) and papaya (141.0g). Relatively weakest plant (125.1g) was produced in combination with eucalyptus trees (Table 22).

Okra: Morphological characters of okra like plant height, leaves plant^{-1}, fruit length and fruit girth were significantly influenced by different trees (Table 22, Fig. 11b). Tallest plant (90.5 cm) was found in association with guava tree (114.8cm) which was statistically similar with plant height produced along with mahogony (114.4cm), lombu (114.2cm), mango (113.8cm) and in control condition (112.5cm). Statistically similar size plant was produced in association with akashmoni (103.4cm), lemon (105.2cm), and jujube (104.5cm). Plant height in association with eucalyptus (92.5cm) and papaya (93.6cm) was almost similar as third highest. Shortest plant was found in association with karanja tree (83.6cm). Leaves plant^{-1}, fruit length and fruit girth also varied in association with different trees in similar pattern like Plant height where highest value was observed in control condition (68.4, 18.1cm and 7.1cm) and lowest in association with karanja tree (36.3, 10.2cm and 3.9cm).

Yield

Fresh yield: Fresh yield of all four summer vegetables, i.e., kangkong, indian spinach, amaranth and okra were significantly influenced by different tree combination (Table 23). Highest yield was produced under without tree condition and fresh yield without tree condition of kangkong,

indian spinach, amaranth and okra was 50.2, 62.5, 18.0 and 32.5 tha^{-1}. This yield was reduced along with different tree combination in different rate. Second highest yield was produced in combination with mahogoni, lombu, mango and guava where 6-12% yield was reduced as compared to without tree combination. Third highest yield was obtained from akashmoni, lemon and jujube mixed combination with summer vegetables where 15-28% fresh yield was decreased as compared to control condition. Fourth highest yield recorded in combination with Eucalyptus and papaya where 30-38% yield reduced compare to without tree combination. In case of kangkong and indian spinach least fresh yield was obtained in association with hijal and karanja where 40-45% yield was reduced as compared to control combination.

Dry yield: Like fresh yield, dry yield was also influenced by different tree combination in a similar trend (Table 23). Highest dry yield was obtained in control condition for kangkong, indian spinach, amaranth and okra were 4.45, 3.85, 1.77 and 2.38 tha^{-1} and in tree-vegetables association dry yield was reduced similarly like fresh yield (Table 23). Dry yield was produced in control condition where moisture was reduced 88-90% where as in tree-vegetables mixed combination moisture was reduced to 92-94%.

Table 23. Yield of summer vegetables in association with different tree species

Tree species		Yield (t ha^{-1})							
		Kangkong		Indian spinach		Amaranth		Okra	
		Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
Timber trees	1. Akashmoni	42.1c	3.78cd	52.5c	3.15c	12.9c	1.39c	26.4c	1.80c
	2. Mahogony	47.0b	4.14b	57.6b	3.46b	15.8b	1.57b	29.3b	2.02b
	3. Lombu	48.8b	4.29ab	58.7b	3.52b	16.0b	1.58b	29.4b	2.02b
	4. Eucalyptus	36.3d	3.57d	43.8d	2.87d	10.5d	1.30d	24.5d	1.66d
Fruit trees	5. Mango	46.5b	4.09b	56.7b	3.40b	16.0b	1.61b	28.5b	1.95b
	6. Lemon	41.5c	3.96c	53.5c	3.21c	13.3c	1.44c	26.2c	1.79c
	7. Jujube	42.0c	3.91c	53.6c	3.22c	12.8c	1.40c	25.7c	1.75c
	8. Papaya	36.2d	3.61d	44.6d	2.68d	10.5d	1.27d	23.5d	1.59d
	9. Guava	46.3b	4.07b	56.4b	3.38b	15.7b	1.62b	28.3b	2.03b
soil conserving tress	10. Hijal	35.1d	1.78e	32.5ef	1.95f	_	_	_	_
	11. Karanja	36.5d	1.92e	35.7e	2.14e	9.2e	0.75e	15.5e	1.01e
Without tree		50.2a	4.45a	62.5a	3.85a	18.0a	1.77a	32.5a	2.38a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$

Yield of Papaya: Among the different tree species yield was produced from only papaya (Table 24 and Fig.12). Papaya yield was highest (33.5 tha^{-1}) in control condition, i.e., without vegetable mixed combination. Statistically similar yield was obtained from papaya in mixed vegetables combination with all vegetables and average yield was 30.25 tha^{-1}, which was near 10% less as compared to control condition (Table 24).

Fig. 12. Papaya along with summer vegetables

Table 24. Yield of Papaya in association with summer vegetables

Vegetables	Yield (t/ha)
Kangkong	29.8b
Indian spinach	30.5b
Amaranth	30.2b
Okra	30.6b
Without vegetables	33.5a

Means in column followed by the different letter are significantly different by DMRT at P ? 0.05

Yield of all studied summer vegetables was higher in open field condition and in the tree-vegetable association, vegetables yield was reduced in different rate along with different trees. Along with mahogony, lombu, mango and guava summer vegetable produced highest yield which was 6-12% lower as compared to open field condition, along with akashmoni, lemon and jujube produced 15-28% lower, along with eucalyptus and papaya produced 30-38% lower and along with hijal and karanja produced 40-45% lower yield as compared to open field condition. Papaya yield was also reduced (≤10%) along with summer vegetables. Generally, in agroforestry system components yield was reduced due to resource competition (Rao *et al.* 1998; Puri and Bangarwa, 1992; Dhillon *et al.* 1998). In association with hijal and karanja highest (40-45%) vegetables yield reduced may be due to excess humid condition. As earlier discussed the growth of summer vegetables was lower in combination with different trees at different rate, this reason also may be responsible for lowering yield of these vegetables. There is another reason responsible for yield reduction was space occupied by tree sapling by its own volume (3-4% area). Average dry yield of all summer vegetables was 9.13% of fresh yield in open field condition and 8.79% when vegetables grown in association with trees, i.e., 0.34% greater in open field condition. These results indicate fresh yield under tree, i.e., partial shade condition content more water than open field condition. Wadud and Miah (2000, 2001) observed fresh yield under shade condition content because it contened more water compare to open field condition in kangkong and okra. They

opined the possible cause of this higher water content was less transpiration under shade condition.

Considering the results and discussion of this study it is clear that summer vegetables cultivation in the charland areas of Bangladesh will be a profitable agroforestry practice in association with different fruit, timber as well as soil conserving tree species.

Winter season 2012: Yield and yield attributes of six different winter vegetables were observed in three different experiments. These were (i) Performance of five winter vegetables in association with akashmoni tree (ii) Sweetgourd cultivation along with different tree species during winter season (iii) Effects of different tree species on the growth and yield of bittergourd. Data gathered from each experiment are presented below:

(i) Performance of five winter vegetables in association with akashmoni tree

Morphological characteristics: Except plant height, all other morphological parameters of radish, sweetgourd, chilli, carrot and coriander was slightly increased in open field condition as compared to combined condition (Table 25 and Fig. 13). Almost all tested vegetable species was slightly taller (3-7%) in association with akashmoni trees but in sweet gourd tallest plant was observed without tree condition. Number of fruits/leaves per plant, fruit/root length and individual fruit/root weight was partially increased (5-10%) without aklasmoni tree association or open field condition (Table 25 and Fig 13).

Table 25. Morphological characteristics of winter vegetables in association with *Acacia auriculiformis* tree

Vegetables	Morphological Characteristics							
	Plant height (cm)		No. of fruits/leaves plant^{-1}		Fruit/root length (cm)		Weight per fruit /root plant^{-1} (g)	
	with trees	without trees	with trees	without trees	with trees	without trees	with trees	without trees
1. Radish	53.5	50.5	..	..	24.5	27.7	178.5	191.5
2. Chilli	75.8	72.5	95.5	99.5	6.2	6.9	3.2	3.7
3. Carrot	46.7	43.5	..	..	18.2	19.8	134.5	146.0
4. Sweet gourd	279.2	304.6	12.5	14.3	17.6	19.6	1975.8	2035.5
5. Coriander	21.5	20.2	10.5	11.8	..	..	1.5	1.8

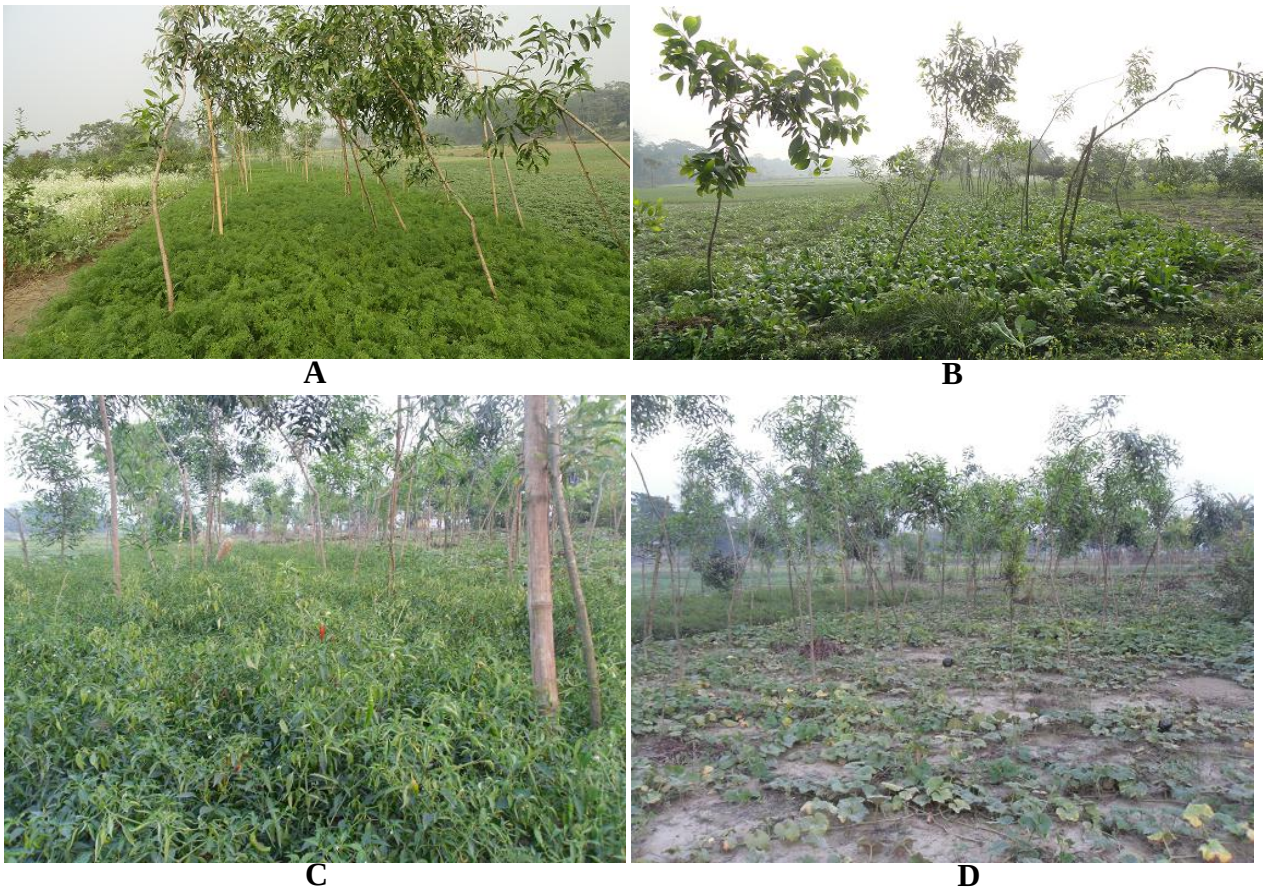

Fig. 13. Winter vegetables in association with Akashmoni tree (A) Carrot, (B) Radish, (C) Chilli (D) Sweetgourd

Yield: Like morphological parameters yield of radish, chilli, carrot, sweetgourd and coriander was 12.4, 12.6, 11.5, 9.3 and 15.1% lower along with akashmoni combination as compared to open field condition (Fig. 14).

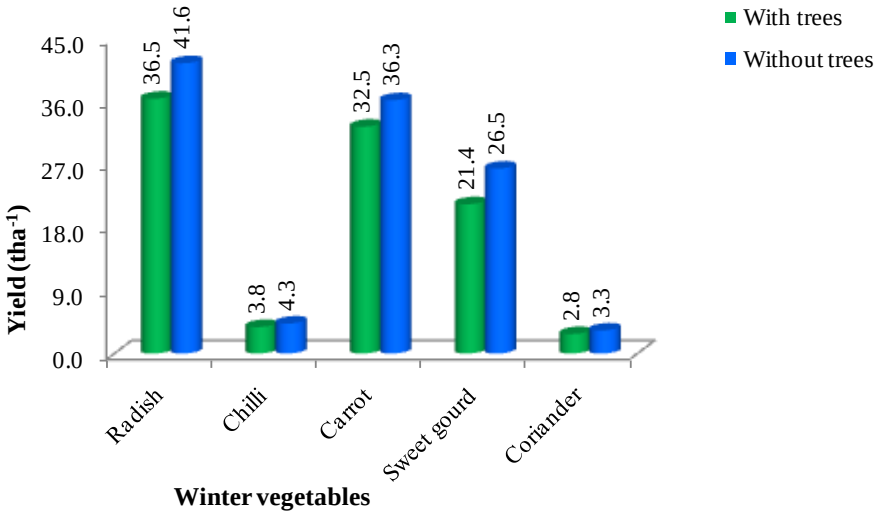

Fig. 14. Yield of different winter vegetables along with akashmoni based agroforestry system

(ii) Sweet gourd cultivation along with different tree species during winter season

Morphological characteristics: Morphological characteristics of sweet gourd viz. plant height, number of primary branches per plant, number of leaves per primary branch, number of fruit per plant and individual fruit weight were significantly influenced by different tree species (Table 26 and Fig. 15). Similar size sweet gourd plant was found in the open field condition and along with mango tree which were the tallest as compared to others. Second highest size sweet gourd plant was found in association with guava and jujube tree. Third highest size sweet gourd plant was found in association with akashmoni tree and lowest size was observed along with lemon tree. Number of primary branches per plant, number of leaves per primary branch, number of fruit per plant and individual fruit weight of sweet gourd was highest in the open field condition and second highest as well as statistically similar value of these parameters was in association with mango, guava and jujube tree and along with other tree species (Table 26).

Table 26. Morphological characteristics of bitter gourd in association with different trees during winter season

Tree species	Morphological Characteristics of bitter gourd				
	Plant height (cm)	No. of primary branches /plant	No. of leaves /primary branch	No. of fruit /plant	Weight /fruit (g)
1. Eucalyptus	111.5d	5.9cd	36.8c	23.5c	36.9cd
2. Lombu	114.5cd	6.1c	37.2bc	23.8bc	37.3c
3. Mahogony	121.5b	7.2b	40.5b	24.7b	40.5b
4. Karanja	128.5a	8.3a	44.9a	27.8a	44.7a
5. Guava	120.1b	7.3b	42.1b	24.8b	41.0b
6. Mango	120.5b	7.2b	41.2b	25.5b	40.4b
7. Lemon	109.5d	5.4d	33.1d	21.3d	34.3d
8. Without tree	129.5a	8.7a	45.3a	28.5a	45.5a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$.

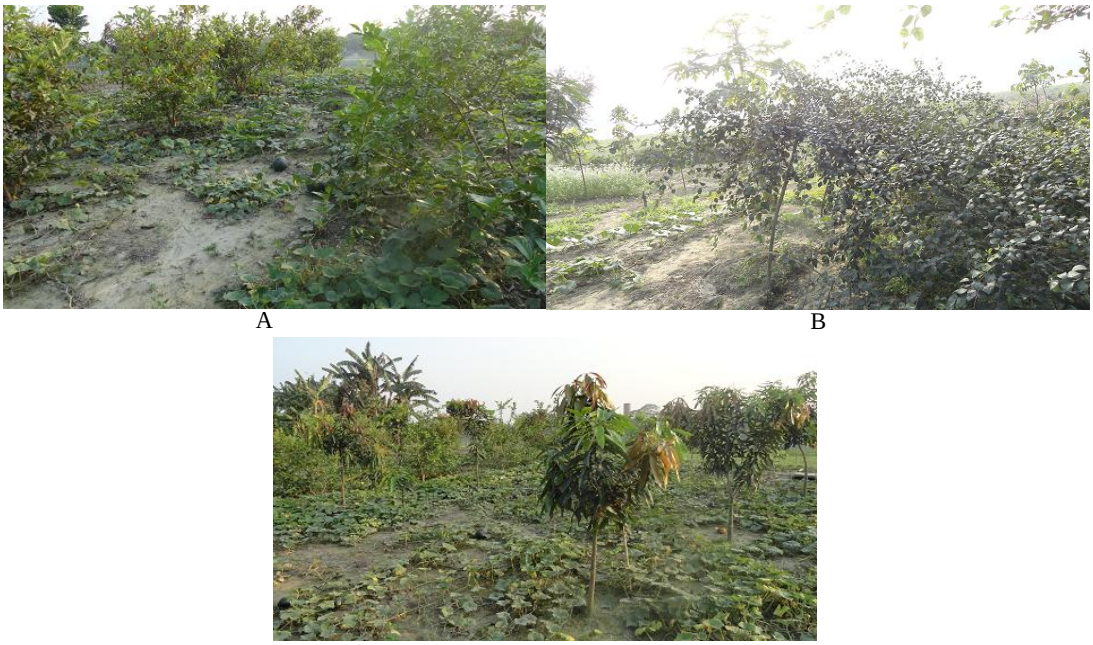

Fig. 15. Sweet gourd cultivation along with (A) Guava & Lemon, (B) Jujube and (C) Mango tree.

Yield: Like morphological parameters, yield of sweet gourd also significantly influenced by different tree species (Fig. 16). Highest yield (25.0 tha^{-1}) was recorded in the open field condition and statistically similar yield was found in association with mango (23 tha^{-1}), guava (22.5 tha^{-1}), jujube (22 tha^{-1}) and akashmoni (21.4 tha^{-1}) which was second highest in this experiment. Lowest yield (18.8 tha^{-1}) was recorded in association with lemon plant which was 26% lower as compared to open field condition.

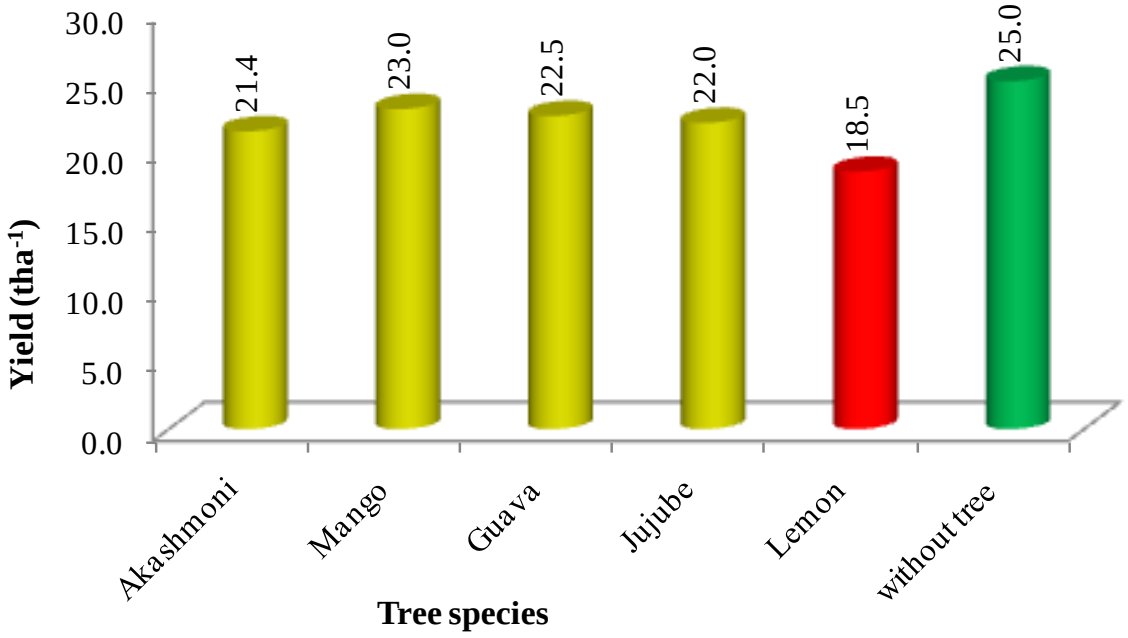

Fig. 16. Yield of different sweet gourd in association different tree species during winter season.

(iii) Effects of different tree species on the growth and yield of bitter gourd

Morphological characteristics: Morphological characteristics of bitter gourd, viz., plant height, number of primary branches per plant, leaves per primary branch, fruit per plant and individual fruit weight was significantly influenced by different tree species (Table 27 and Fig. 17). Similar size bitter gourd plant was found in the open field condition (129.5 cm) and in association with karanja (128.5 cm) tree which were the tallest compare to others. Second highest size bitter gourd plant was found in association with mahogony (121.5 cm), guava (120.1 cm) and mango (120.5 cm) tree. Statistically similar size bitter gourd plant was found in association with eucalyptus (111.5 cm), lombu (114.5 cm) and lemon (109.5 cm) tree species which was the lowest size plant compare to other tree species (Table 3). Like plant height, number of primary branches per plant, leaves per primary branch, fruit per plant and individual fruit weight of bitter gourd was also highest in the open field condition and in association with karanja tree. Second highest as well statistically similar value of these parameters was in association with mango, guava and mahogony tree. Third highest as well as statistically similar value of these parameters was in association with eucalyptus and lombu tree species. Lowest of these growth parameters was recorded in association with lemon trees (Table 27).

Table 27. Morphological characteristics of sweet gourd in association with different trees during winter season

Tree species	Morphological Characteristics of sweet gourd				
	Plant height (cm)	No. of primary branches/plant	No. of leaves /branch	No. of fruit /plant	Weight /fruit (g)
1. Akashmoni	279.2c	8.7bc	14.8bc	10.7b	1698.1c
2. Mango	298.6a	9.2b	15.9b	11.5b	1817.5b
3. Guava	292.1b	9.1b	15.8b	11.1b	1779.1b
4. Jujube	285.7bc	8.9bc	15.4b	10.9b	1737.7bc
5. Lemon	240.2d	7.4c	12.9c	9.2c	1462.8d
6. Without tree	304.6a	10.8a	17.5a	12.5a	1975.8a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$.

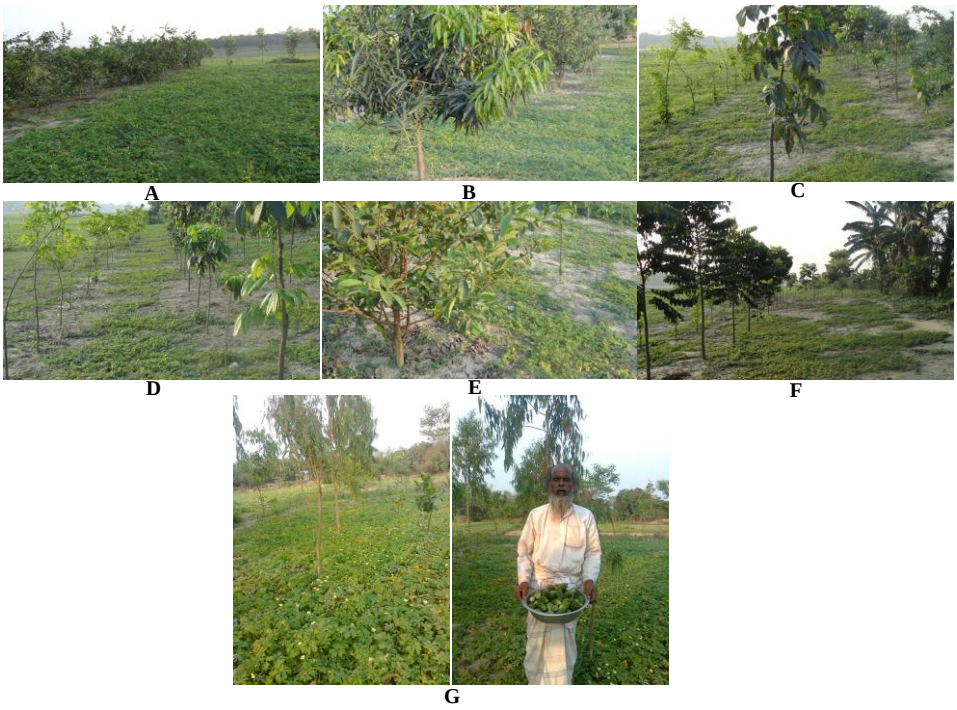

Fig. 17. Bitter gourd cultivation along with (A) Lemon, (B) Mango, (C) Mahogoni, (D) Karanja, (E) Guava, (F) Lombu and (G) Eucalyptus tree.

Yield: Like growth parameters, yield of bitter gourd was also significantly influenced by different tree species (Fig. 18). Highest yield was recorded in the open field condition (4.1 tha^{-1}) which was statistically similar with the yield of Bitter gourd produced in association with Karanja tree (3.95 tha^{-1}). Second highest and statistically similar yield of bitter gourd obtained along mahogony (3.45 tha^{-1}), guava (3.42 tha^{-1}) and mango (3.95 tha^{-1}) tree. Third highest and statistically similar yield of bitter gourd recorded in association with eucalyptus (3.2 tha^{-1}) and lombu (3.26 tha^{-1}) tree. Lowest yield (18.8 tha^{-1}) was recorded in association with lemon plant which was 29.26 % lower compare to open field condition (Fig. 18).

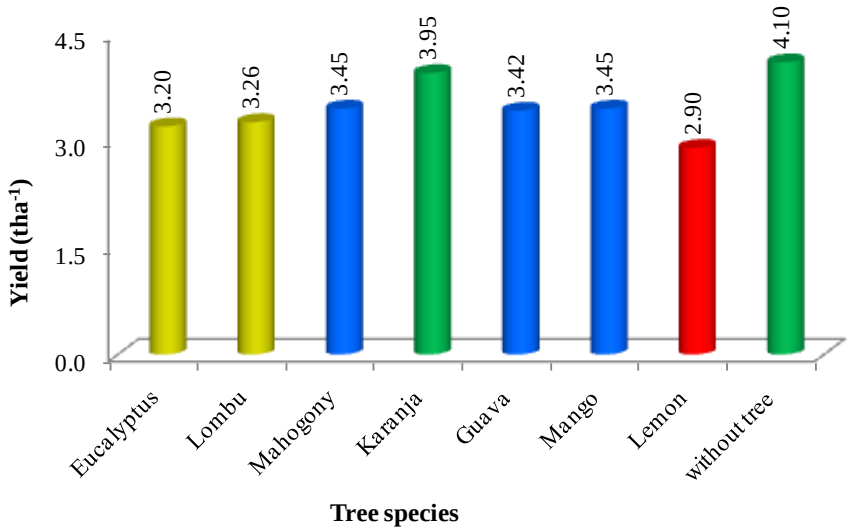

Fig. 18. Yield of different bitter gourd in association different tree species during winter season

In the first experiment it was found that yield of radish, chilli, carrot, sweet gourd and coriander was 10-15% higher in open field condition compare to in association with akashmoni tree. In this study akshmoni tree was two years old which have relatively spread crown and root system compare to first year of plantation. For this reason there is competition for moisture and nutrients very near the tree base of akashmoni tree (Puri and Bangarwa, 1992). This may be reason for yield reduction of these winter vegetables of this experiment. Due to the same reason reduced yield was observed by Mallick *et al.* (2013) in Strawberry and Habib *et al.,* (2012) in different summer vegetables along with *Xylia dolabriformis* tree. In the second and third experiment it was found that yield of Sweet gourd and Bitter gourd was also higher in open field condition and it was maximum upto 26-30% lower in association with lemon tree. This may be also due to the competition for growth resources between trees and vegetables, moreover Lemon is bushy type tree which have dominant surface root system, this may be the another reason for lowering of growth of vegetables along this tree. Competition for moisture and nutrients in agroforestry systems is common occurring phenomenon, which can affect the system adversely for both trees and crops (Ong *et al.,* 1991; Rao *et al.,* 1991). Similar observation was also reported by Islam *et al.,* (2009) in *Hopea odorata* and Khatun *et al.,* (2009) in *Swintonia floribunda* along with winter vegetables. Considering the results of these studies it is clear that 'though the yield of winter vegetables was reduced in different rate in the char base farming system but it is profitable considering the benefits from tree, viz., fruit, fuel, fodder, timber, soil and environment amelioration.

Summer season 2013: Yield and yield attributes of four different summer vegetables were observed in three different experiments. These were (i) Performance of summer vegetables in association with different fruit trees (ii) Summer vegetables cultivation in association with different timber trees (iii) Summer vegetables production in association with hijal and karanja trees. Data gathered from each experiment are presented below:

(i) Performance of summer vegetables in association with different fruit trees:

Morphological characteristics: Except plant length/height, all other morphological parameters of kangkong, indian spinach, amaranth and okra were slightly decreased in contact with tree species compared with open field condition (Table 28). Almost all tested vegetables species heights were increased without amaranth. kangkong increased 8 to 16%, indian spinach increased 10 to 15%, and okra increased 0.9 to 10% in association with different tree species, viz., mango, limon and guava. Amaranth plant height decreased 0.9% in association with Lemon but

increased 2% and 4% in contact with mango and guava. Length of all vegetable species were comparatively decreased in contact with lemon than mango and guava (Table 28).

Table 28. Morphological Characteristics of summer vegetables in association with different fruit tree species

Tree species	Morphological Characteristics of summer vegetables															
	Kangkong				Indian spinach					Amaranth			Okra			
	Length twig^{-1} (cm)	Branches plant^{-1}	Leaves plant^{-1}	Stem girth (cm)	Length twig^{-1} (cm)	Branches plant^{-1}	Leaves plant^{-1}	Stem girth (cm)	Plant height (cm)	Leaves plant^{-1}	Stem girth (cm)	Weight plant^{-1} (g)	Plant height (cm)	Leaves plant^{-1}	Fruit length (cm)	Fruit girth (cm)
1. Mango	29.2a	11.9ab	315.3b	2.82b	38.4a	7.6b	212.0b	3.4b	80.2a	28.1b	8.2b	168.8b	101.2a	60.8c	16.6b	6.4b
2. Lemon	27.4b	10.9bc	278.4d	2.53d	36.7bc	6.8c	197.8d	3.1c	77.8c	26.6cd	8,0bc	165.0bc	93.3b	58.2d	14,4d	5.6cd
4. Guava	28.3ab	11.5b	302.2c	2.61c	38.2a	7.4b	200.1c	3.2c	81.4a	27.0c	7.9cd	161.3c	101.2a	61,5b	15.4c	5.9c
Without trees	25.5c	12.8a	335.5a	2.91a	33.5c	8.5a	235.5a	3.7a	78.5b	31.1a	9.2a	185.5a	92.5b	68.4a	18.1a	7.1a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$

Yield of summer vegetables: Like morphological parameters yield of kangkong, indian spinach, amranth and okra was significantly influenced in association with mango, guava and lemon tree (Fig. 19). In all vegetables highest yield was found in open field condition where as 15-20% yield was reduced along with mango trees, 19-23% yield was reduced along with guava trees and highest 23-28% yield reduction was recorded in association with lemon trees (Fig. 19).

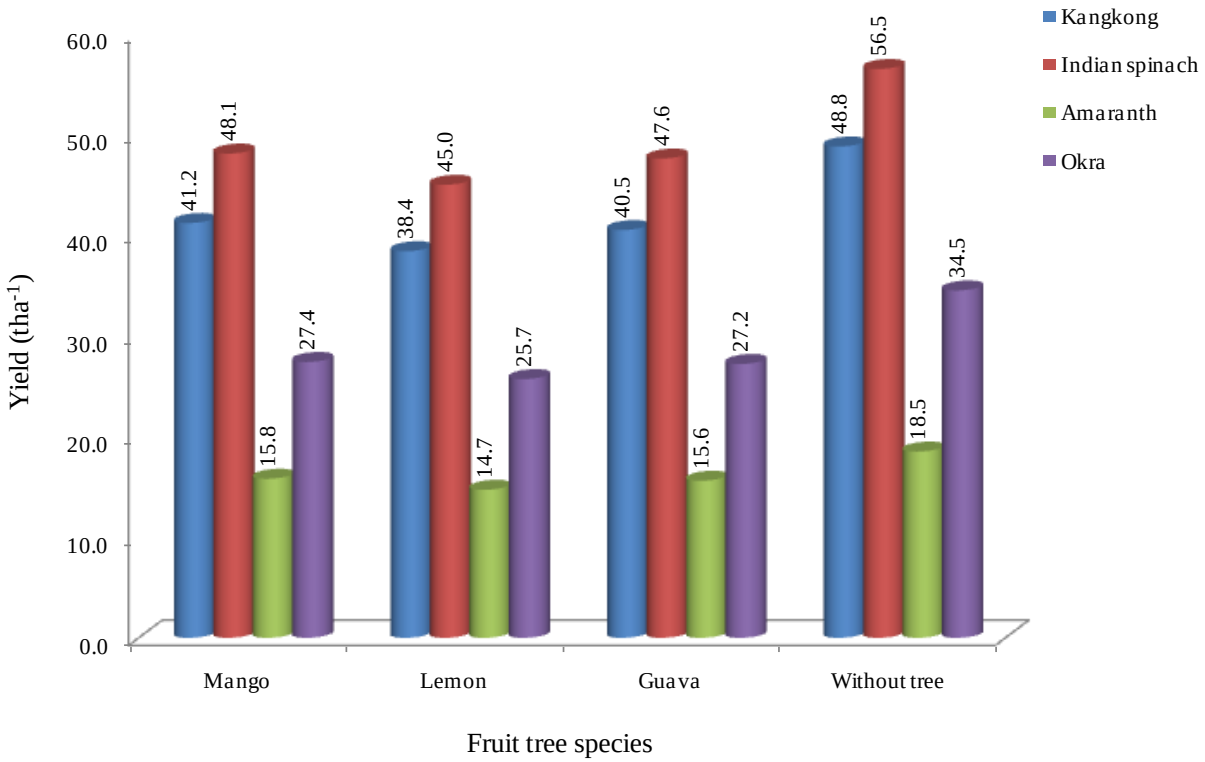

Fig. 19. Yield of different summer vegetables along with fruit trees

Yield of Fruits: Like vegetables yield fruit yield was also partially influenced in association with kangkong, indian spinach, amranth and okra (Fig. 20). Yield of mango, guava and lemon was highest in open field condition (2.50, 18.55 and 7.50 tha^{-1}) followed by along with okra (2.15, 15.50 and 6.30 tha^{-1}), kangkong (2.04, 14.60 and 5.85 tha^{-1}), indian spinach (1.95, 14.25 and 5.70 tha^{-1}) and amaranth (1.85, 13.50 and 5.50 tha^{-1}). Highest yield reduction was recorded in combination with amaranth (26-28%) followed by indian spinach (22-24%), kangkong (19-22%) and okra (14-17%).

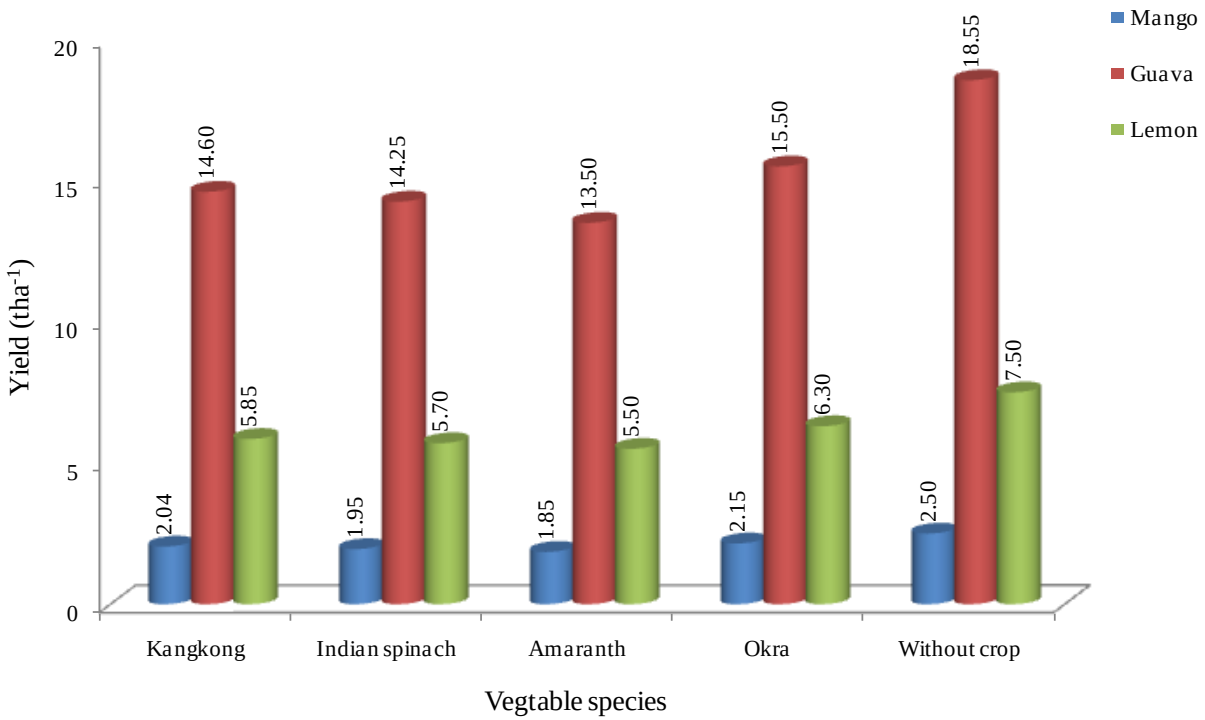

Fig. 20. Yield of different fruit species in association with different summer vegetables

Land Equivalent Ratio (LER): The term Land Equivalent Ratio (LER) was derived from its indication of relative land requirements for intercrops versus monocultures. LER help to judge the relative performance of a component of a crop combination compared to sole stands of that species. LER is the sum of relative yields of the components species. Relative yield is the ratio of a component yield as intercrops and its sole stands in any agroforestry system. If *LER = 1*, there was no advantage (i.e., neutral) to intercropping or agroforestry in comparison to sole cropping. If *LER > 1*, indicate better use of resources or positive interaction between the components. If *LER < 1*, indicate the competition, i.e., negative interactions between the components. In this study it was found that LER for different combination of summer vegetables (kangkong, indian spinach, amranth and okra) and fruit trees (mango, guava and lemon) was more than 1 (Table 29) which indicate combind production of summer vegetables and fruit trees is profitable.

Table 29. LER vale in different fruit tree and summer vegetable combination

Tree-Vegetable combination	Land Equivalent Ratio (LER)
1. Mango-Kangkong	1.66
2. Mango-Indian spinach	1.63
3. Mango-Amaranth	1.59
4. Mango-Okra	1.65
5. Lemon-Kangkong	1.56
6. Lemon-Indian spinach	1.55
7. Lemon-Amaranth	1.52
8. Lemon-Okra	1.58
9. Guava-Kangkong	1.61
10. Guava-Indian spinach	1.61
11. Guava-Amaranth	1.57
12. Guava-Okra	1.62

(ii) Summer vegetables cultivation in association with different timber trees

Morphological characteristics: Except plant height/length, all other morphological parameters of kangkong, indian spinach, amaranth and okra, viz., branches plant^{-1}, leaves plant^{-1}, girth of stems plant^{-1} were slightly increased in open field condition compared to combined condition (Table 30). Length of twig^{-1} of kangkong was increased 7 to 14%, indian spinach increased 2 to 16%, plant height of amaranth increased 3 to 10% and plant height of okra 8 to17% increased in contact with different tree species. Length of twigs or height of plants of all experimental vegetable species was maximum in contact with lambu, medium increased in association with akashmoni and mahogoni which was more or less similar and lowest increase was in contact with eucalyptus (Table 30).

Table 30. Morphological Characteristics of summer vegetables in association with different timer tree species

Tree species	Morphological Characteristics of summer vegetables															
	Kangkong				Indian spinach				Amaranth				Okra			
	Length twig^{-1} (cm)	Branches plant^{-1}	Leaves plant^{-1}	Stem girth (cm)	Length twig^{-1} (cm)	Branches plant^{-1}	Leaves plant^{-1}	Stem girth (cm)	Plant height (cm)	Leaves plant^{-1}	Stem girth (cm)	Weight plant^{-1} (g)	Plant height (cm)	Leaves plant^{-1}	Fruit length (cm)	Fruit girth (cm)
1. Akashmoni	28.7ab	10.3c	298.5c	2.62c	36.1b	7.4b	207.2c	3.3c	82.3bc	27.3c	7.5c	167c	100.1b	58.1c	15.7cd	6.0c
2. Mahogony	28.0b	11.3b	301.9bc	2.71b	38.2a	7.6b	214.3bc	3.5b	83.2b	27.6c	8.1b	170.7bc	103.5ab	60.1bc	17.1b	6.4c
3. Lombu	29.2a	11.5b	308.7b	2.9a	38.8a	7.9ab	223.7b	3.4bc	86.9a	28.0b	8.6b	176.2b	108.0a	62.2b	16.2c	6.7b
4. Eucalyptus	27.4c	10.1c	265.0d	2.56c	34.4c	6.8c	188.4d	3.1d	80.5c	24.8d	7.2c	154.0d	95.6c	54.7d	14.4d	5.6d
Without trees	25.5d	12.8a	335.5a	2.91a	33.5d	8.5a	235.5a	3.7a	78.5d	31.1a	9.2a	185.5a	92.5d	68.4a	18.1a	7.1a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$

Yield: Yield of kangkong, indian spinach, amranth and okra was partially influenced in association with different timber trees, i.e., akashmoni, mahogony, lombu and eucalyptus (Fig. 21). Yield of kangkong, indian spinach, amranth and okra was highest in open field condition (48.8, 56.5, 18.5 and 34.5 tha^{-1}) followed by along with mahogony (39.0, 45.4, 15.0 and 26.0 tha^{-1}), lombu (37.6, 43.9, 14.3 and 25.1 tha^{-1}), akashmoni (35.3, 40.1, 13.1 and 22.9 tha^{-1}) and eucalyptus (33.0, 38.5, 12.6 and 22.0 tha^{-1}). Highest yield reduction was recorded in combination with eucalyptus (32-37%) followed by akashmoni (28-34%), lombu (23-28%) and mahogony (19-25%).

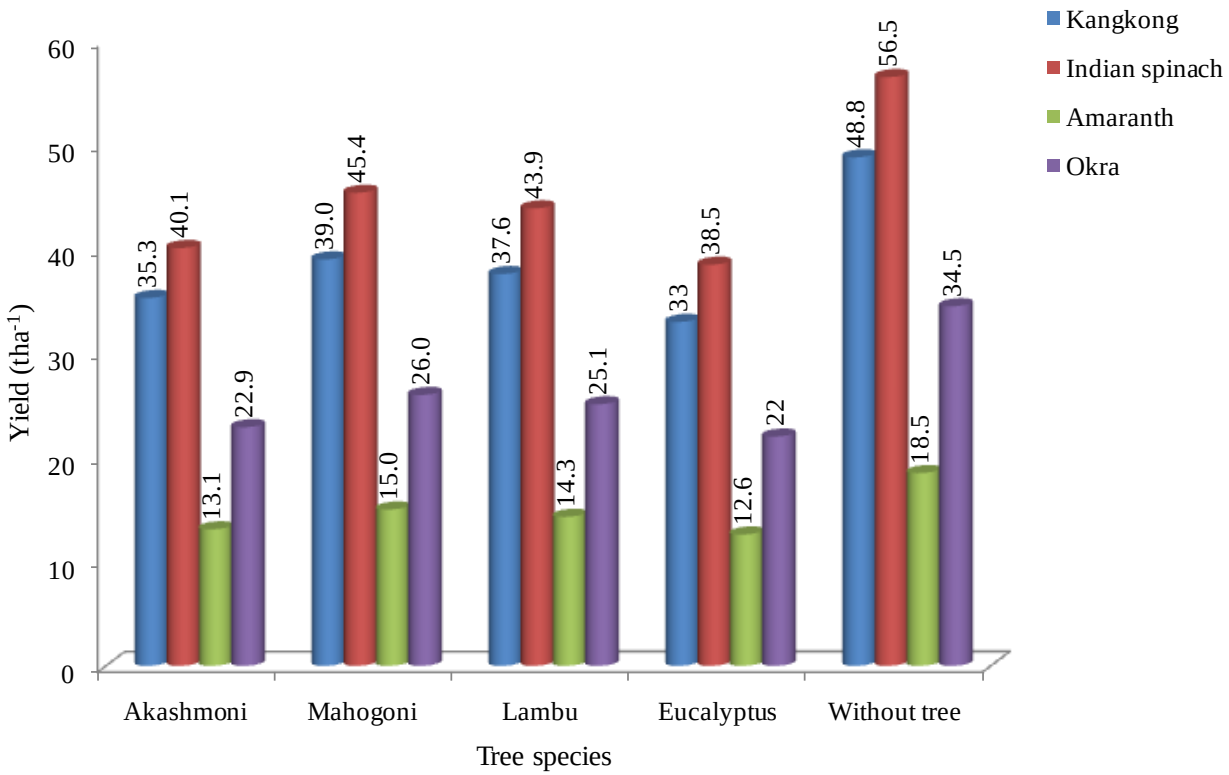

Fig. 21. Yield of different summer in association different timber tree species

(iii) Summer vegetables production in association with Hijal and Karanja trees

Morphological characteristics: All morphological characteristics of kangkong, indian spinach, amaranth and okra except length of twigs or plant height, viz., branches $plant^{-1}$, leaves $plant^{-1}$, girth of stems $plant^{-1}$ were slightly decreased in association with hijal and karanja compared without tree condition (Table 31). The length of twigs of kangkong increased by 7% and 5%, Indian spinach increased 8% and 2%, Plant height of okra 7% and 0.8% in contact with hijal and karanja gradually but plant height of amaranth decreased 2% in contact with hijal and 4% increased in association with karanja (Table 31).

Table 31. Morphological Characteristics of summer vegetables in association with different timer tree species

Tree species	Morphological Characteristics of summer vegetables															
	Kangkong				Indian spinach				Amaranth			Okra				
	Length twig^{-1} (cm)	Branches plant^{-1}	Leaves plant^{-1}	Stem girth (cm)	Length twig^{-1} (cm)	Branches plant^{-1}	Leaves plant^{-1}	Stem girth (cm)	Plant height (cm)	Leaves plant^{-1}	Stem girth (cm)	Weight plant^{-1} (g)	Plant height (cm)	Leaves plant^{-1}	Fruit length (cm)	Fruit girth (cm)
1. Hijal	27.4a	10.9c	288.5bc	2.44c	36.4a	7.4bc	207.2c	3.1c	76.9c	27.3b	7.9bc	163.2b	99.0a	60.1b	15.9b	6.2b
2. Karanja	26.8b	11.2b	299.0b	2.61b	34.4b	7.6b	214.3b	3.2b	81.4a	24.9c	8.3b	154.0c	93.3b	56.8c	14.4c	5.6c
Without trees	25.5c	12.8a	335.5a	2.91a	33.5c	8.5a	235.5a	3.7a	78.5b	31.1a	9.2a	185.5a	92.5b	68.4a	18.1a	7.1a

Means in column followed by the different letter are significantly different by DMRT at P ≤ 0.05

Yield: Yield of kangkong, indian spinach, amranth and okra was also partially influenced in association with hijal and karanja (Fig. 22). Yield of kangkong, indian spinach, amranth and okra was highest in open field condition (48.8, 56.5, 18.5 and 34.5tha^{-1}) followed by along with hijal (40.0, 47.0, 15.4 and 27.0 tha^{-1}) and karanja (38.0, 44.4, 14.5 and 25.3 tha^{-1}). Yield of kangkong, indian spinach, amranth and okra was 22-27% was reduced in association with karanja tree and 17-22% with hijal tree.

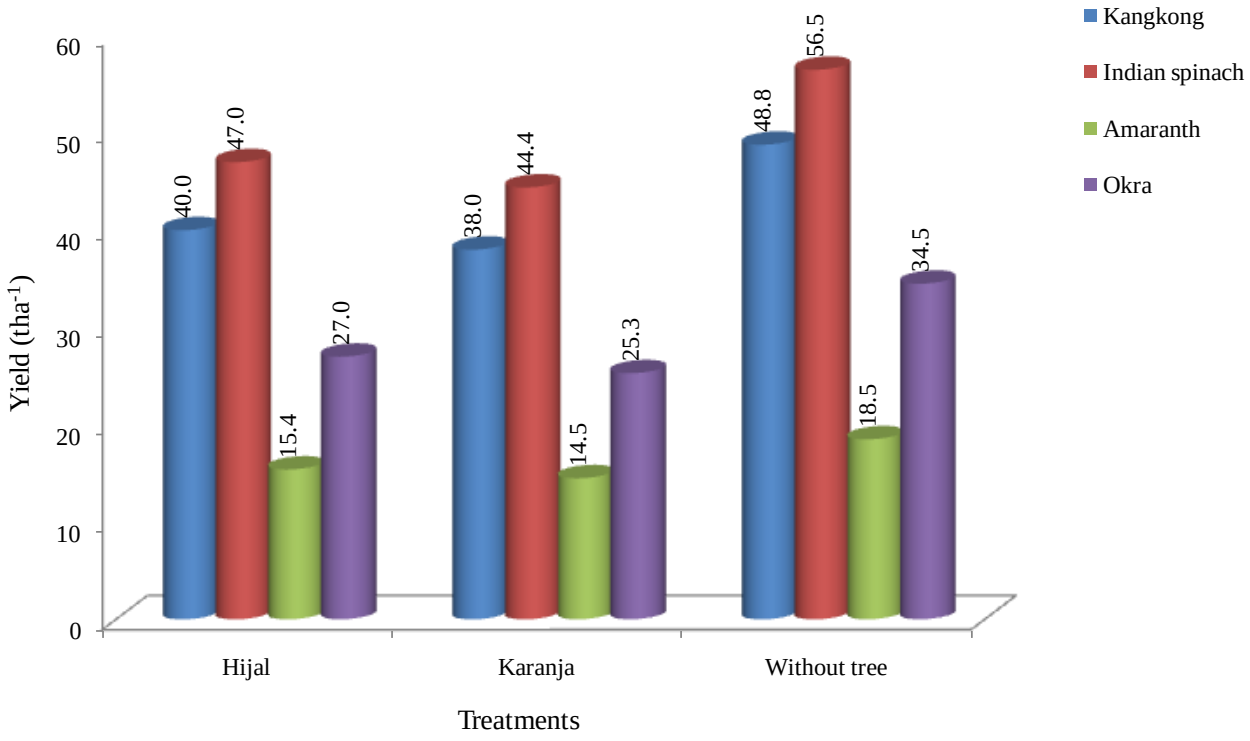

Fig. 22. Yield of different summer vegetables in association with hijal, karanja and without tree condition

Like previous summer season yield of okra, amaranth, kangkong and indian spinach was reduced in association with different fruit, timber and soil conserving tree species but the rate of reduction

gradually increased over time. In this summer season increase yield reduction may be due to partial shade effect, competition for nutrients and moisture with different trees. Gradually increased yield reduction was observed by Basak *et al.* (2009), Tanni *et al.* (2010), Habib *et al.* (2012) and Mallick *et al.*, (2013) in different vegetables/crops along with *Xylia dolabriformis* tree with increasing age of tree.

Winter season 2013: Yield and yield attributes of four different winter vegetables were observed in three different experiments. These were (i) performance of seven winter vegetables in association with akashmoni tree (ii) Sweet gourd cultivation along with different fruit tree species during winter season (iii) Sweet gourd cultivation along with different timber tree species during winter season. Data gathered from each experiment are presented below:

(i) performance of 7 winter vegetables in association with Akashmoni tree

Morphological characteristics: Except plant height, all other morphological parameters of sweet potato, potato, radish, chilli, carrot, sweetgourd, and coriander was slightly increased in open field condition as compared to combined condition (Table 32 and Fig. 23). Almost all tested vegetable species was slightly taller (4-8%) in association with akashmoni trees but in sweet gourd tallest plant was observed without tree condition. Number of tuber/fruits/leaves per plant, tuber/fruit/root length and individual tuber/fruit/root weight was partially increased (10-20%) without Aklasmoni tree association or open field condition (Table 32 and Fig 23).

Table 32. Morphological characteristics of winter vegetables in association with Acacia auriculiformis tree

Vegetables	Morphological Characteristics							
	Plant height (cm)		No. of tuber/fruits/leaves plant^{-1}		Tuber/fruit/root length (cm)		Weight per tuber/fruit /root plant^{-1}	
	with trees	without trees	with trees	without trees	with trees	without trees	with trees	without trees
1. Sweet Potato	72.0	70.5	12.0	13.7	13.5	15.2	310.5	325.0
2. Potato	45.5	47.3	9.2	9.8	9.8	10.5	450.5	471.5
3. Radish	48.5	46.0	10.0	11.5	22.5	25.7	151.5	170.5
4. Chilli	71.5	69.5	83.5	89.5	6.0	6.5	3.0	3.5
5. Carrot	44.3	43.0	10.0	12.0	17.0	18.5	121.5	137.0
6. Sweet gourd	255.2	284.5	12.0	14.0	15.5	17.5	1850.5	1995.0
7. Coriander	19.5	20.5	11.5	12.5	..	..	1.2	1.5

Fig. 23. Winter vegetables in association with Akashmoni tree (A) Sweet potato, (B) Potato, (C) Radish, (D) Chilli, (E) Carrot, (D) Sweetgourd and (G) Coriander

Yield: Like morphological parameters yield of sweet potato, potato, radish, chilli, carrot, sweetgourd, and coriander were 11.3, 16.2, 15.4, 17.8, 17.1, 52.1 and 18.0% lower along with akashmoni combination as compared to open field condition (Fig. 24).

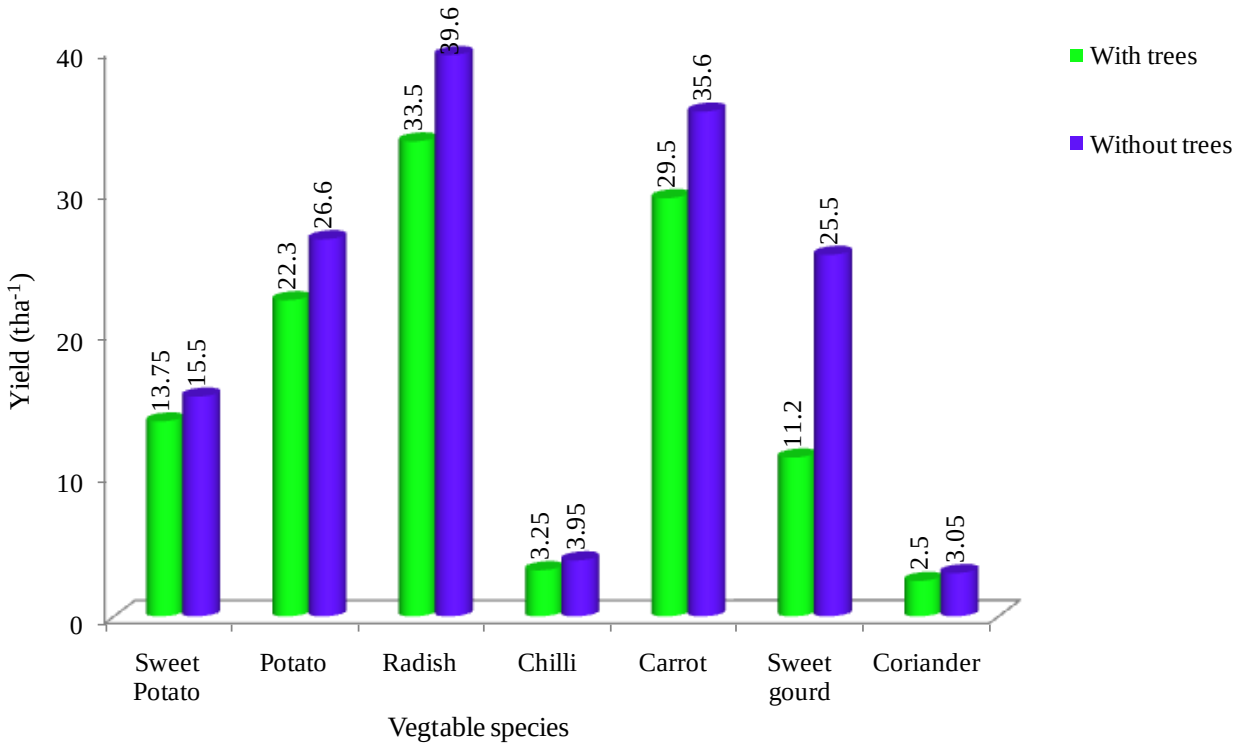

Fig. 24. Yield of different winter vegetables with Akashmoni trees during winter 2013

(ii) Sweet gourd cultivation along with different fruit tree species during winter season

Morphological characteristics: Morphological characteristics of sweet gourd, viz., plant height, number of primary branches per plant, number of leaves per primary branch, number of fruit per plant and individual fruit weight were significantly influenced by different fruit tree species, viz., mango, guava, jujube, lemon, etc. (Table 33 and Fig. 25). Relatively taller plants of sweet gourd were found in the mono/sloe cropping system. Statistically similar size sweet gourd plant was found in association with mango and guava (Table 33) which was 10-15% lower compare to sole cropping system. Similar size plants of sweet gourd were found in association with jujube and lemon trees which were 15-20% shorter compare to its sole cropping system. Number of primary branches per plant, number of leaves per primary branch, number of fruit per plant and individual fruit weight of sweet gourd was highest in its sole cropping system. In agroforestry system performance of these parameters was relatively lower compare to its sole stands where similar effect was found along with mango and guava trees where only 10-15% lower performance was recorded where as in association with jujube and lemon trees growth of the above parameters of sweet gourd was more lower (15-25%) compare to its sole stands (Table 33).

Table 33. Morphological characteristics of sweet gourd in association with different fruit trees during winter season

Tree species	Morphological Characteristics of sweet gourd				
	Plant height (cm)	No. of primary branches/plant	No. of leaves /branch	No. of fruit /plant	Weight /fruit (g)
1. Mango	275.5b	8.1b	14.5b	9.5b	1410.5b
2. Guava	270.1b	7.9b	13.8b	9.1b	1405.0b
3. Jujube	245.5c	6.5bc	11.4c	6.5c	1230.0bc
4. Lemon	230.0c	5.8cd	11.0c	6.2c	1180.8c
5. Without tree	295.5a	9.5a	16.5a	11.5a	1750.0a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$.

A B C D

Fig. 25. Sweet gourd cultivation along with (A) Mango, (B) Guava, (C) Jujube and (D) Lemon tree

Yield of sweet gourd: Like morphological parameters, yield of sweet gourd also significantly influenced by different fruit tree species (Fig. 26). Highest yield of sweet gourd (25.5 tha^{-1}) was recorded when cultivated as sole cropping system but in association with different fruit trees yield of sweet gourd was reduced upto 50% (Fig. 26). Yield reduction of sweet gourd was much higher in association with lemon and jujube trees where 47.8 and 49.8% yield was reduced compare to its sole condition where as yield reduction with mango (35.35) and guava (37.6%) was bit higher compare to sole cultivation of sweet gourd (Fig. 26).

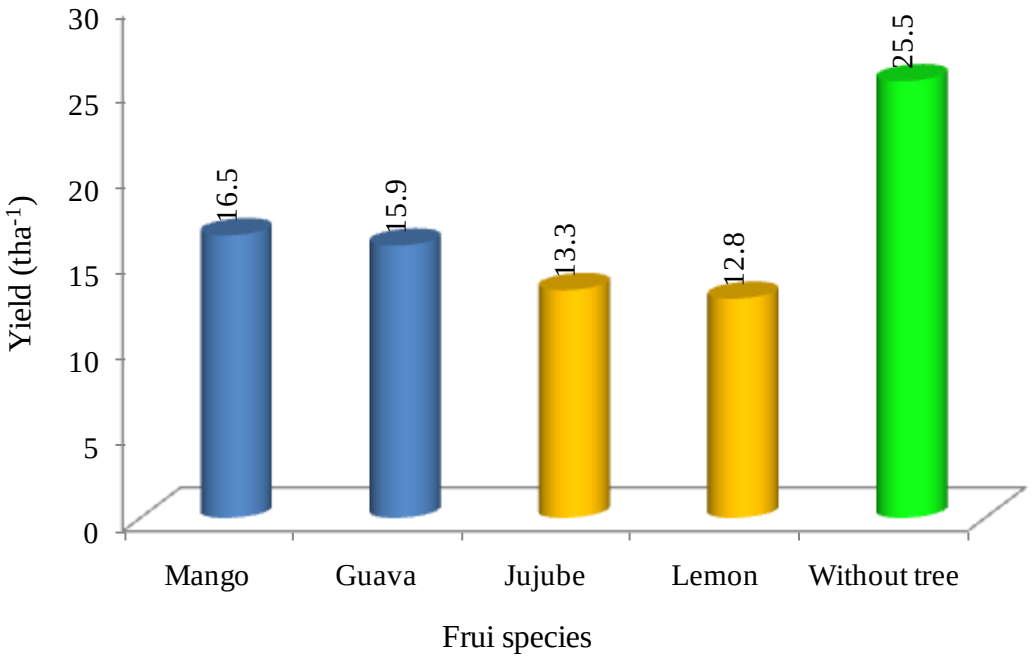

Fig. 26. Yield of sweet gourd in association different fruit tree species during winter season 2013

Yield of Fruits: During winter 2013 different fruits, viz., mango, guava, jujube, lemon, etc., was harvested from all research plots (Fig. 27). Like sweet gourd yield, yield of mango, guava, jujube and lemon was also partially influenced in association with sweet gourd (Fig. 28). Only near 10% yield of these fruit species was reduced along with sweet gourd. Yield of mango, guava, jujube and lemon in association with sweet gourd and without sweet gourd condition were 8.5, 2.75, 10.5 and 7.5 tha^{-1} and 9.5, 3.0, 11.5 and 8.3 tha^{-1}(Fig. 28).

Fig. 27. Fruits of (A) Mango, (B) Guava, (C) Jujube and (D) Lemon along with sweet gourd in the research field

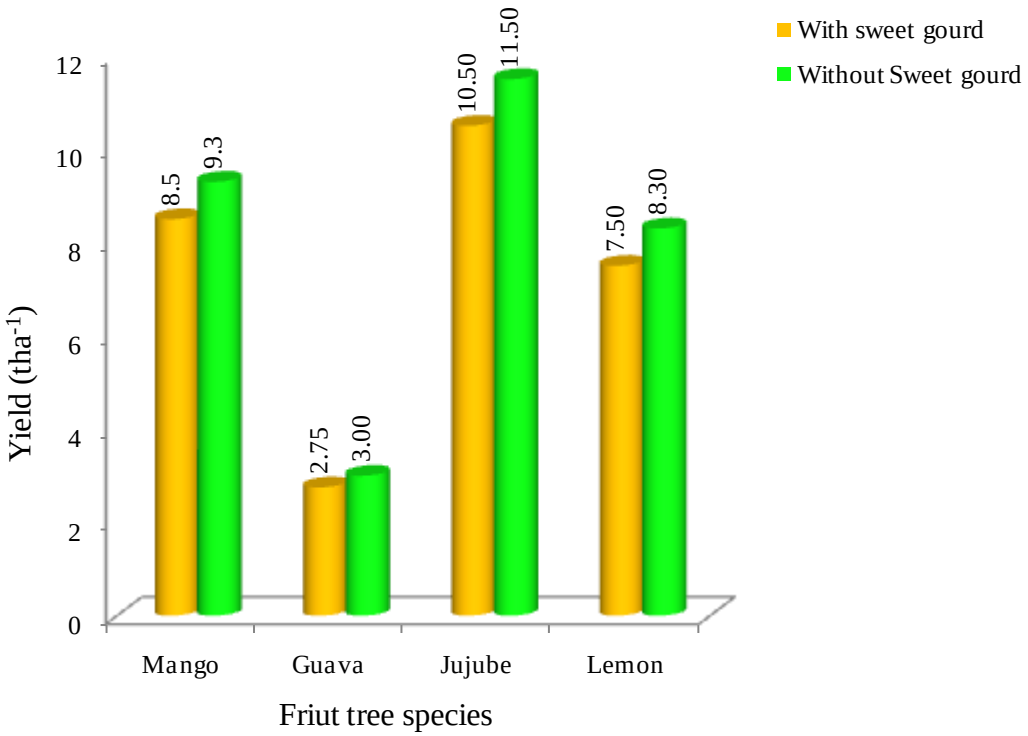

Fig. 28. Yield of different fruits with and without sweet gourd condition

Land Equivalent Ratio (LER): The term Land Equivalent Ratio (LER) was derived from its indication of relative land requirements for intercrops versus monocultures. LER help to judge the relative performance of a component of a crop combination compared to sole stands of that species. LER is the sum of relative yields of the components species. Relative yield is the ratio of a component yield as intercrops and its sole stands in any agroforestry system. If *LER = 1*, there was no advantage (i.e., neutral) to intercropping or agroforestry in comparison to sole cropping. If *LER > 1*, indicate better use of resources or positive interaction between the components. If *LER < 1*, indicate the competition, i.e., negative interactions between the components. In this study it was found that LER for sweet gourd and different fruit trees (mango, guava jujube and lemon) was more than one (Table 34) which indicate combind production of sweet gourd with mango, guava jujube and lemon is profitable.

Table 34. LER value in different fruit tree in association with sweet gourd

Tree-Vegetable combination	Land Equivalent Ratio (LER)
Mango-sweet gourd	1.57
Lemon-sweet gourd	1.42
Guava-sweet gourd	1.55
Jujube-sweet gourd	1.45

(iii) Sweet gourd cultivation along with different timber tree species during winter season

Morphological characteristics: Morphological characteristics of sweet gourd, viz., plant height, number of primary branches per plant, number of leaves per primary branch, number of fruit per plant and individual fruit weight were significantly influenced by different timber tree species, viz., akashmoni, lombo and karanja, etc., (Table 35 and Fig. 29). Relatively taller plants of sweet gourd were found in the mono/sloe cropping system. Statistically similar size sweet gourd plant was found in association with lombo and karanja (Table 35) which was 10-15% lower compare to sole cropping system. In association with akashmoni trees near 30% shorter plant was recorded compare to its sole cropping system. Number of primary branches per plant, number of leaves per primary branch, number of fruit per plant and individual fruit weight of sweet gourd was highest in its sole cropping system. In agroforestry system performance of these parameters was relatively lower compare to its sole stands where similar effect was found along with lombo and karanja trees where only 10-15% lower performance was recorded where as in association with akashmoni trees growth of the above parameters of sweet gourd was more lower (near 30%) compare to its sole stands (Table 35).

Table 35. Morphological characteristics of sweet gourd in association with different timber trees during winter season

Tree species	Morphological Characteristics of sweet gourd				
	Plant height (cm)	No. of primary branches/plant	No. of leaves /branch	No. of fruit /plant	Weight /fruit (g)
1. Akashmoni	230.0c	5.8c	11.0c	6.2c	1180.8c
2. Lombu	265.5b	7.5b	13.2b	8.8b	1380.0b
3. Karanja	269.0b	7.7b	13.5b	9.0b	1400.0b
4. Without tree	295.5a	9.5a	16.5a	11.5a	1750.0a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$.

A B C

Fig. 29. Sweet gourd cultivation along with (A) Akashmoni, (B) Lombo and (C) Karanja tree

Yield of sweet gourd: Like morphological parameters, yield of sweet gourd also significantly influenced by different timber tree species (Fig. 30). Highest yield of sweet gourd (25.5 tha^{-1}) was recorded when cultivated as sole cropping system but in association with different timber trees yield of sweet gourd was reduced upto near 50% (Fig. 30). Yield reduction of sweet gourd was much higher in association with akashmoni trees where 55.1% yield was reduced compare to its sole condition where as yield reduction with lombo (32.4%) and karanja (28.6%) was bit lower compare to sole cultivation of sweet gourd (Fig. 30).

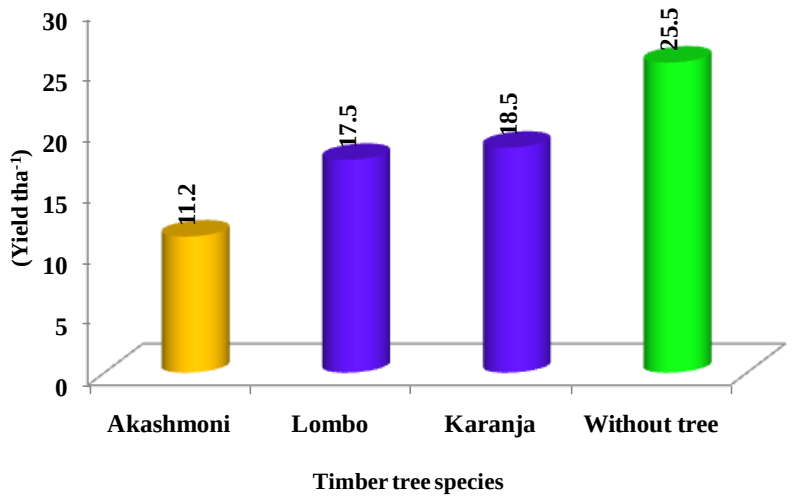

Fig. 30. Yield of sweet gourd with different timber trees during the winter 2013

10.5 Growth of trees along with vegetables

Growth means a permanent and irreversible increase in size and form, which results as height and diameter increment. For growth measurement Current Annual Increment (CAI) and Mean Annual Increment (MAI) are two important indices. For determining CAI and MAI height and diameter measurement are basic requirement. Diameter (D) was determined from girth (G) as $D = (G \div \pi)$. Except papaya height and girth of other 10 tree species were recorded annually, viz., 2011, 2012, 2013 and 2014.

During 2011 height and girth of the planted tree species was increased in different rate both in combination with different vegetables and without vegetables condition (Table 36). In combination with different vegetables highest height (185.2 cm) and girth (10.1cm) increment was observed in eucalyptus tree and lowest height (32.3 cm) and girth (2.1cm) increment was observed in mahogoni and hijal (Table 36). Similar trend of height and girth increment was also found in control condition i.e., without vegetables condition where highest height (196.9 cm) and girth (10.5 cm) and lowest height (35.5 cm) and girth (2.2 cm) were in eucalyptus and hijal (Table 36). It is mentionable that both height and girth increment was a bit higher in control condition compare to combined production system, i.e., agroforestry system.

Table 36. Growth of different tree species during the 2011 with and without vegetables combination

Tree species	Growth of trees with vegetables						Growth of trees without vegetables condition					
	Height (cm)			Girth (cm)			Height (cm)			Girth (cm)		
	1st	2nd	Increment	1st	2nd	Increment	1st	2nd	Increment	1st	2nd	Increment
1. Akashmoni	127.0	321.5	194.5	2.8	10.4	7.6	127.0	330.5	203.5	2.8	10.6	7.8
2. Mahogony	132.1	164.4	32.3	3.0	9.1	6.1	132.1	170.9	38.8	3.0	9.3	6.3
3. Lombu	43.2	134.7	91.5	1.2	11.2	10.0	43.2	137.5	94.3	1.2	11.5	10.3
4. Eucalyptus	134.6	319.8	185.2	3.2	13.3	10.1	134.6	331.5	196.9	3.2	13.7	10.5
5. Mango	88.9	157.7	68.8	3.1	12.8	9.7	88.9	163.8	74.9	3.1	13.2	10.1
6. Lemon	63.5	146.6	83.1	2.7	9.8	7.1	63.5	154.8	91.3	2.7	10.4	7.7
7. Jujube	30.5	119.4	88.9	1.5	8.7	7.2	30.5	129.1	98.6	1.5	9.1	7.6
8. Guava	66.1	140.4	74.3	2.9	11.2	8.3	66.1	147.7	81.6	2.9	11.4	8.5
9. Hijal	20.5	55.8	35.3	1.8	3.9	2.1	20.5	56.0	35.5	1.8	4.0	2.2
10. Karanja	33.1	107.9	74.8	1.0	5.3	4.3	33.1	114.7	81.6	1.0	5.7	4.7

In the year 2012 height and girth of different planted tree species was also increased in different rate both in combination with different vegetables and without vegetables condition (Table 37). In combination with different vegetables highest height (157.8 cm) and girth (10.7 cm) increment was observed in karanja and mahogoni tree. Lowest height (34.7 cm) and girth (3.5 cm) increment was observed in hijal and mango (Table 37). Similar trend of height and girth increment was also found in control condition, i.e., without vegetables condition where highest height (162.1 cm) and girth (10.6 cm) was karanja and mahogony (Table 37) and the lowest height (40.1 cm) and girth (3.8 cm) was in hijal and mango (Table 37). In this year, i.e., end of second year both height and girth increment was also bit higher in without vegetable condition and rate on increase was similar with first year increment.

Table 37. Growth of different tree species during the 2012 with and without vegetables combination

Tree species	Growth of trees with winter vegetables						Growth of trees without vegetables condition					
	Height (cm)			Girth (cm)			Height (cm)			Girth (cm)		
	1st	2nd	Increment	1st	2nd	Increment	1st	2nd	Increment	1st	2nd	Increment
1. Akashmoni	321.5	418.4	96.9	10.4	16.4	6.0	330.5	430.7	100.2	10.6	17.0	6.4
2. Mahogony	164.4	253.5	89.1	9.1	19.8	10.7	170.9	258.5	87.6	9.3	19.9	10.6
3. Lombu	134.7	247.0	112.3	11.3	19.2	7.9	137.5	255.4	117.9	11.5	19.8	8.3
4. Eucalyptus	319.8	442.7	122.9	13.3	19.2	5.9	331.5	454.6	129.1	13.7	19.9	6.2
5. Mango	157.7	221.5	63.8	12.8	16.3	3.5	163.8	230.9	67.1	13.2	17.0	3.8
6. Lemon	146.6	235.6	89.0	9.8	19.1	9.3	154.8	247.5	92.7	10.4	19.8	9.4
7. Jujube	119.4	209.5	90.1	8.7	17.0	8.3	129.1	219.4	90.3	9.1	18.4	9.3
8. Guava	140.4	196.8	56.4	11.2	16.5	5.3	147.7	205.6	57.9	11.4	17.2	5.8
9. Hijal	55.8	90.5	34.7	3.9	8.0	4.1	56.0	96.1	40.1	4.0	8.3	3.4
10. Karanja	107.9	265.7	157.8	5.3	14.1	8.8	114.7	276.8	162.1	5.7	14.4	8.7

Height and girth of all planted tree species was increased in different rate both in combination with different vegetables and without vegetables condition during the year 2013 (Table 38).

Current Annual Increment (CAI) of eucalyptus tree was surprisingly several times higher for both height and girth either with or without vegetables combination (Table 38). Height and girth increment of eucalyptus in association with different vegetables and without vegetables combination was 607.3 cm & 21.2 cm and 602.4 cm & 20.9 cm. Interestingly, CAI for both height and girth was little higher in association with different vegetables combination. Lowest height and girth increment were 25.6 cm and 4.2 cm in mango and guava, in association with different vegetables. In case of control, i.e., without vegetables lowest height and girth increment were 1.2 cm and 2.6 cm in mango and lemon (Table 38).

Table 38. Growth of different tree species during the 2013 with and without vegetables combination

Tree species	Growth of trees with summer vegetables						Growth of trees without vegetables condition					
	Height (cm)			Girth (cm)			Height (cm)			Girth (cm)		
	1st	2nd	Increment	1st	2nd	Increment	1st	2nd	Increment	1st	2nd	Increment
1. Akashmoni	418.4	571.0	152.6	16.4	21.2	4.8	430.7	573.0	142.3	17.0	21.9	4.9
2. Mahogony	253.5	325.0	71.5	19.8	24.7	4.9	258.5	327.0	68.5	19.9	25.4	5.5
3. Lombu	247.0	439.1	192.1	19.2	26.6	7.4	255.4	443.1	187.7	19.8	27.3	7.5
4. Eucalyptus	442.7	1050.0	607.3	19.2	30.4	11.2	454.6	1057.0	602.4	19.9	31.8	11.9
5. Mango	221.5	247.1	25.6	16.3	21.3	5.0	230.9	249.1	16.2	17.0	20.2	3.2
6. Lemon	235.6	331.0	95.4	19.1	23.5	4.4	247.5	333.0	85.5	19.8	22.4	2.6
7. Jujube	209.5	310.0	108.5	17.0	25.2	8.8	219.4	314.0	94.6	18.4	28.0	9.6
8. Guava	196.8	283.5	86.7	16.5	20.7	4.2	205.6	287.5	81.4	17.2	21.8	4.6
9. Hijal	90.5	123.0	23.5	8.0	14.5	6.5	96.1	126.0	29.9	8.3	15.0	6.7
10. Karanja	265.7	318.8	53.1	14.1	25.5	11.4	276.8	323.8	47.0	14.4	26.8	12.4

Height and Girth of all planted tree species was increased in different rate both in combination with different vegetables and without vegetables condition during the year 2014 (Table 39). Average height increment with and without vegetables was 126.9 and 96.0 cm(Table 39). Average girth increment with and without vegetables was 11.0 and 8.6 cm (Table 39).

Table 39. Growth of different tree species during the 2014 with and without vegetables combination

Tree species	Growth of trees with summer vegetables						Growth of trees without vegetables condition					
	Height (cm)			Girth (cm)			Height (cm)			Girth (cm)		
	1st	2nd	Increment	1st	2nd	Increment	1st	2nd	Increment	1st	2nd	Increment
1. Akashmoni	418.4	602.5	184.1	16.4	22.7	6.3	430.7	563.0	132.3	17.0	20.9	3.9
2. Mahogony	253.5	345.1	91.6	19.8	28.3	8.5	258.5	327.2	68.7	19.9	26.9	7.0
3. Lombu	247.0	449.6	202.6	19.2	32.0	12.8	255.4	429.7	174.3	19.8	30.2	10.4
4. Eucalyptus	442.7	745.5	302.8	19.2	38.7	19.5	454.6	721.4	266.8	19.9	35.3	15.4
5. Mango	221.5	251.0	29.5	16.3	22.9	6.6	230.9	240.1	9.2	17.0	21.1	4.1
6. Lemon	235.6	353.0	117.4	19.1	25.7	6.6	247.5	315.0	67.5	19.8	24.4	4.6
7. Jujube	209.5	317.0	107.5	17.0	34.7	17.7	219.4	287.2	67.8	18.4	31.7	13.3
8. Guava	196.8	309.8	113.0	16.5	23.0	6.5	205.6	285.9	80.3	17.2	20.8	3.6
9. Hijal	90.5	153.3	62.8	8.0	16.6	8.6	96.1	157.3	61.2	8.3	16.7	8.4
10. Karanja	265.7	322.9	57.2	14.1	31.1	17.0	276.8	308.7	31.9	14.4	29.2	14.8
Average			**126.9**			**11.0**			**96.0**			**8.6**

Mean Annual Increment (MAI) of all tree species was statistically similar both for height (Fig. 31) and girth increment (Fig. 32). Critically it was found that MAI value was numerically little higher in control condition as compared to in association with vegetables (Figures 31 and 32). Highest MAI was in eucalyptus tree both in association with vegetables and control i.e., without vegetables condition and lowest in hijal tree. Highest MAI values for height in association with vegetables and control condition was 305.1 & 309.5 cm, and for girth was 9.1 & 9.5 cm. Lowest MAI values for height in association with vegetables and control condition was 31.2 & 35.2 cm, and for girth was 4.2 & 4.1 cm.

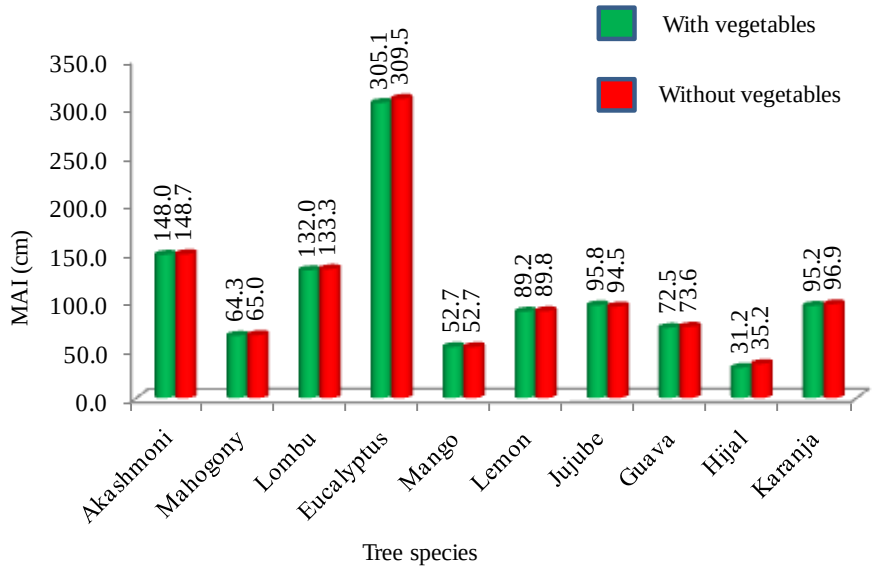

Fig. 31. Mean Annual Increment (MAI) for height in different tree species

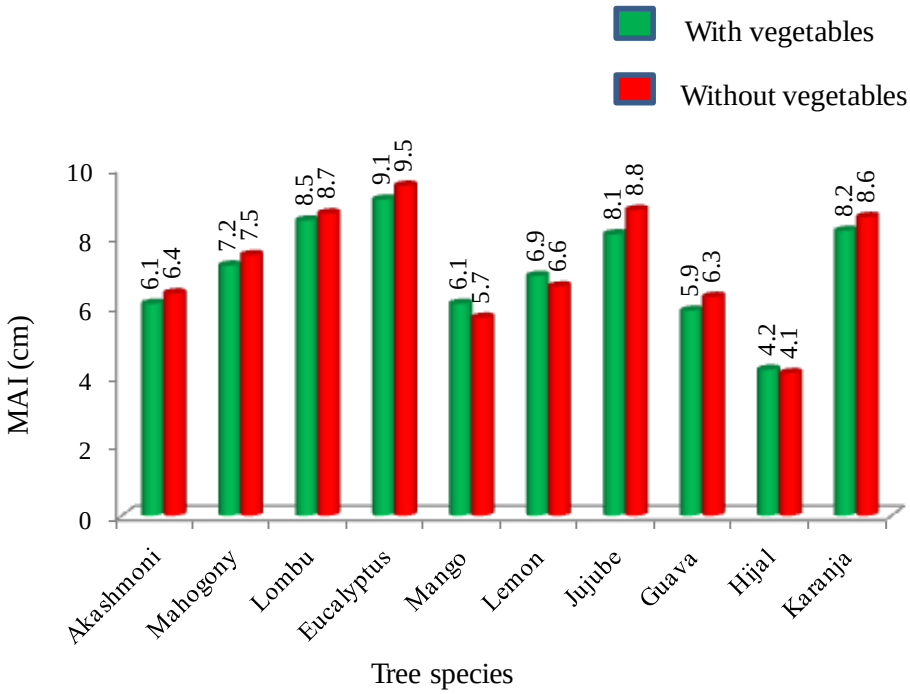

Fig. 32. Mean Annual Increment (MAI) for girth in different tree species

10.6 Farmers income

Farmers income was determined separately for the char areas of Mymensingh and Jamalpur from the research plots of selected farmers. The income was also separately estimated for summer and winter season for every financial year and these were as follows:

Year 2011-2012: In this financial year income from the research plots of selected farmers were also recorded for Mymensingh and Jamalpur district separately as for winter and summer season. It was found that in Mymensingh district total net income of this year was Tk 79477 of which Tk.47772 from winter season and Tk. 31705 from summer season (Table 40a). In case of Jamalpur district it was found that in Mymensingh district total net income of this year was Tk. 64614 of which Tk. 41000 from winter season and Tk. 23614 from summer season (Table 40b).

Table 40a. Income (Tk.) from the farmers plot in the year 2011-2012 from the Char areas of Mymensingh district

Name of the farmers	Land area (ha)	Winter			Summer			Total		
		Return	Cost	Gross income	Return	Cost	Gross income	Return	Cost	Gross income
Hamid Fakir	0.68	37735	9305	28430	28850	6365	22485	62885	15500	47385
Yunus Ali	0.25	5115	1300	3815	1800	450	1350	5765	1100	4665
Liakot Miah	0.19	3068	790	2278	1940	500	1440	4548	1000	3548
Mohosin	0.13	1622	380	1242	500	100	400	1622	300	1322
Hafiz Uddin	0.19	3400	640	2760	600	110	490	10350	2490	7860
Md. Tara Miah	0.18	2385	600	1785	1220	1820	920	5545	1170	4375
Liton	0.09	5200	1215	3985	2500	680	1820	5200	1050	4150
Shaheb Ali	0.07	1500	300	1200	1000	200	800	2520	480	2040
Tota Miah	0.08	990	240	750	1200	210	990	3390	780	2610
Liakot Ali	0.19	1872	345	1527	1200	190	1010	1872	350	1522
Total	2.05	62887	15115	47772	40810	9105	31705	103697	24220	79477

Table 40b. Income (Tk.) from the farmers plot in the year 2011-2012 from the Char areas of Jamalpur district

Name of the farmers	Land area (ha)	Winter			Summer			Total		
		Return	Cost	Gross income	Return	Cost	Gross income	Return	Cost	Gross income
Muktel Hossen	0.152	6750	1610	5140	7900	2250	5650	19550	5500	14050
Boshir Uddin	0.096	2400	440	1960	4660	1300	3360	10120	2420	7700
Shahaj	0.102	5575	970	4605	3900	1100	2800	12675	3200	9475
Nazrul Islam	0.074	1815	370	1445	2600	650	1950	2015	400	1615
Hanif Uddin	0.064	8550	2770	5780	3030	770	2260	11310	2600	8710
Robiul Islam	0.083	8440	2800	5640	2500	660	1840	9040	1720	7320
Zohurul Islam	0.075	6770	160	6610	2720	600	2120	6214	1200	5014
Monzurul Islam	0.076	7250	1600	5650	2240	550	1690	9730	2150	7580
Foej Uddin	0.065	4950	780	4170	2354	410	1944	3750	600	3150
Total	0.787	52500	11500	41000	31904	8290	23614	84404	19790	64614

Year 2012-2013: Like previous year this financial year income from the research plots of selected farmers were also recorded for Mymensingh and Jamalpur district separately as for winter and summer season. It was found that in Mymensingh district total net income of this year was

Tk.105615 of which Tk. 41100 from winter season and Tk. 65365 from summer season (Table 41a). In case of Jamalpur district it was found that in Mymensingh district total net income of this year was Tk. 70740 of which Tk. 32740 from winter season and Tk. 38000. from summer season (Table 41b).

Table 41a. Income (Tk.) from the farmers plot in the year 2012-2013 from the Char areas of Mymensingh district

Name of the farmers	Land area (ha)	Winter			Summer			Total		
		Return	Cost	Gross income	Return	Cost	Gross income	Return	Cost	Gross income
Hamid Fakir	0.68	32850	9100	23750	50355	14100	36255	83205	23200	60005
Yunus Ali	0.25	2830	510	2320	5300	1220	4080	8130	1730	6400
Liakot Miah	0.19	1200	220	980	4100	900	3200	5300	1120	4180
Mohosin	0.13	1900	380	1520	2130	400	1730	4300	780	3250
Hafiz Uddin	0.19	2840	600	2240	7500	1800	5700	10340	2400	7940
Md. Tara Miah	0.18	2500	550	1950	4200	900	3300	6700	1450	5250
Liton	0.09	6400	1500	4900	5000	1050	3950	11400	2550	8850
Shaheb Ali	0.07	800	150	650	3500	700	2800	4300	850	3450
Tota Miah	0.08	1320	230	1090	2800	500	2300	4120	730	3390
Liakot Ali	0.19	2100	400	1700	2500	450	2050	4600	850	2900
Total	2.05	54740	13640	41100	87385	22020	65365	142395	35660	105615

Table 41b. Income (Tk.) from the farmers plot in the year 2012-2013 from the Char areas of Jamalpur district

Name of the farmers	Land area (ha)	Winter			Summer			Total		
		Return	Cost	Gross income	Return	Cost	Gross income	Return	Cost	Gross income
Muktel Hossen	0.152	4300	900	3400	16300	4500	11850	20600	5400	15250
Boshir Uddin	0.096	2820	500	2320	8500	1800	6700	11320	680	9020
Shahaj	0.102	5030	1150	3880	6700	1400	5300	11730	2550	9180
Nazrul Islam	0.074	1050	200	850	1200	200	1000	2250	400	1850
Hanif Uddin	0.064	6000	1500	4500	5500	1200	4300	11500	2700	8800
Robiul Islam	0.083	7500	2000	5500	3500	700	2800	11000	2700	8300
Zohurul Islam	0.075	5040	1050	3990	2850	550	2300	7890	1600	6290
Monzurul Islam	0.076	6500	1500	5000	3300	700	2600	9800	2200	7600
Foej Uddin	0.065	4200	900	3300	1350	200	1150	5550	1100	4450
Total	0.787	42440	9700	32740	49200	11250	38000	91640	19330	70740

Year 2013-2014: Like previous year this financial year income from the research plots of selected farmers were also recorded for Mymensingh and Jamalpur district separately as for winter and summer season. It was found that in Mymensingh district total net income of this year was Tk.113520.6 of which Tk. 63067 from different vegetables and Tk. 50423.6 from different trees (Table 42a). In case of Jamalpur district it was found that in Mymensingh district total net income of this year was Tk. 67775.4 of which Tk. 37653 obtained from different vegetables and Tk. 30122.4 obtained from different trees (Table 42b).

Table 42a. Income (Tk.) from the farmers plot in the year 2013-2014 from the Char areas of Mymensingh district

Name of the farmers	Land area (ha)	Vegetables			Trees			Total		
		Return	Cost	Gross income	Return	Cost	Gross income	Return	Cost	Gross income
Hamid Fakir	0.68	37500	10000	27500	30000	8000	22000	67500	18000	49500
Yunus Ali	0.25	5860	1057	4803	4688	845.6	3842.4	10548	1902.6	8645.4
Liakot Miah	0.19	2484	456	2028	1987.2	364.8	1622.4	4471.2	820.8	3650.4
Mohosin	0.13	3933	787	3146	3146.4	629.6	2516.8	7079.4	1416.6	5662.8
Hafiz Uddin	0.19	5879	1242	4637	4703.2	993.6	3709.6	10582.2	2235.6	8346.6
Md. Tara Miah	0.18	5175	1135	4040	4140	908	3232	9315	2043	7272
Liton	0.09	13248	3240	10008	10598.4	2592	8006.4	23846.4	5832	18014.4
Shaheb Ali	0.07	1656	307	1349	1324.8	245.6	1079.2	2980.8	552.6	2428.2
Tota Miah	0.08	2733	559	2174	2186.4	447.2	1739.2	4919.4	1006.2	3913.2
Liakot Ali	0.19	4347	965	3382	3477.6	772	2705.6	7824.6	1737	6087.6
Total	2.05	82815	19748	63067	66252	15798.4	50453.6	149067	35546.4	113520.6

Table 42b. Income (Tk.) from the farmers plot in the year 2013-2014 from the Char areas of Jamalpur district

Name of the farmers	Land area (ha)	Vegetables			Trees			Total		
		Return	Cost	Gross income	Return	Cost	Gross income	Return	Cost	Gross income
Muktel Hossen	0.152	4945	1035	3910	3956	828	3128	8901	1863	7038
Boshir Uddin	0.096	3244	575	2669	2595.2	460	2135.2	5839.2	1035	4804.2
Shahaj	0.102	5785	1323	4462	4628	1058.4	3569.6	10413	2381.4	8031.6
Nazrul Islam	0.074	1209	231	978	967.2	184.8	782.4	2176.2	415.8	1760.4
Hanif Uddin	0.064	6900	1725	5175	5520	1380	4140	12420	3105	9315
Robiul Islam	0.083	8625	2300	6325	6900	1840	5060	15525	4140	11385
Zohurul Islam	0.075	5797	1209	4588	4637.6	967.2	3670.4	10434.6	2176.2	8258.4
Monzurul Islam	0.076	7475	1725	5750	5980	1380	4600	13455	3105	10350
Foej Uddin	0.065	4831	1035	3796	3864.8	828	3036.8	8695.8	1863	6832.8
Total	0.787	48811	11158	37653	39048.8	8926.4	30122.4	87859.8	20084.4	67775.4

Comparative income in different financial year: Total income, total cost and net income from the different research plot of individual farmers in the char areas of Mymensingh and Jamalpur district are presented in the Tables 43a and 43b. It was found that income from the different plots in Mymensingh and Jamalpur char areas of this project gradually increased from initial year (2010-2011) year to current year (2013-2014) with a handsome return (Tables 43a and 43b). During the project period total income of all individual farmers from their research plots was several time higher compare to the any year of before project execution. Total income was also gradually increased with increasing the project period in both char areas of Mymensingh and Jamalpur (Figures 33a and 33b). Total gross return in Mymensingh areas in the financial year 2013-2014 was Tk.113521 and Jamalpur it was Tk. 67775.4 which were 7% higher and 4.2% lower compare to previous year (2012-2013), 30 and 4.2% higher compare to the year 2011-2012 and 84 and 74% higher compare to the 2010-2011 (before project execution). It was estimated that cost of these farmers research plots was 21-25% of total income i.e., benefits from the

farmers research plots was 75-79% (Figures 33a and 33b). Depending on the farmers income from before and after project implementation it was clear that agroforestry activities were more suitable for better livelihood in the char areas of Bangladesh.

Table 43a. Total income from the farmers plot in the Char areas of Mymensingh district during different years

Name of the farmers	Land area (ha)	Total income (Tk.)								
		2010-2011	2011-2012			2012-2013			2013-2014	
			Return	Cost	Gross income	Return	Cost	Gross income	Return	Cost	Gross income
Hamid Fakir	0.68	15000	62885	15500	47385	83205	23200	60005	67500	18000	49500
Yunus Ali	0.25	Fallow	5765	1100	4665	8130	1730	6400	10548	1902.6	8645.4
Liakot Miah	0.19	Fallow	4548	1000	3548	5300	1120	4180	4471.2	820.8	3650.4
Mohosin	0.13	Fallow	1622	300	1322	4300	780	3250	7079.4	1416.6	5662.8
Hafiz Uddin	0.19	500	10350	2490	7860	10340	2400	7940	10582.2	2235.6	8346.6
Md. Tara Miah	0.18	Fallow	5545	1170	4375	6700	1450	5250	9315	2043	7272
Liton	0.09	2500	5200	1050	4150	11400	2550	8850	23846.4	5832	18014.4
Shaheb Ali	0.07	Fallow	2520	480	2040	4300	850	3450	2980.8	552.6	2428.2
Tota Miah	0.08	Fallow	3390	780	2610	4120	730	3390	4919.4	1006.2	3913.2
Liakot Ali	0.19	Fallow	1872	350	1522	4600	850	2900	7824.6	1737	6087.6
Total	**2.05**	**18000**	**103697**	**24220**	**79477**	**142395**	**35660**	**105615**	**149067**	**35546.4**	**113520.6**

Table 43b. Total income from the farmers plot in the Char areas of Jamalpur district during different years

Name of the farmers	Land area (ha)	Total income (Tk.)								
		2010-2011	2011-2012			2012-2013			2013-2014	
			Return	Cost	Gross income	Return	Cost	Gross income	Return	Cost	Gross income
Muktel Hossen	0.152	2000	19550	5500	14050	20600	5400	15250	8901	1863	7038
Boshir Uddin	0.096	800	10120	2420	7700	11320	680	9020	5839.2	1035	4804.2
Shahaj	0.102	2550	12675	3200	9475	11730	2550	9180	10413	2381.4	8031.6
Nazrul Islam	0.074	Fallow	2015	400	1615	2250	400	1850	2176.2	415.8	1760.4
Hanif Uddin	0.064	3450	11310	2600	8710	11500	2700	8800	12420	3105	9315
Robiul Islam	0.083	2500	9040	1720	7320	11000	2700	8300	15525	4140	11385
Zohurul Islam	0.075	2600	6214	1200	5014	7890	1600	6290	10434.6	2176.2	8258.4
Monzurul Islam	0.076	2300	9730	2150	7580	9800	2200	7600	13455	3105	10350
Foej Uddin	0.065	1600	3750	600	3150	5550	1100	4450	8695.8	1863	6832.8
Total	**0.787**	**17800**	**84404**	**19790**	**64614**	**91640**	**19330**	**70740**	**87859.8**	**20084.4**	**67775.4**

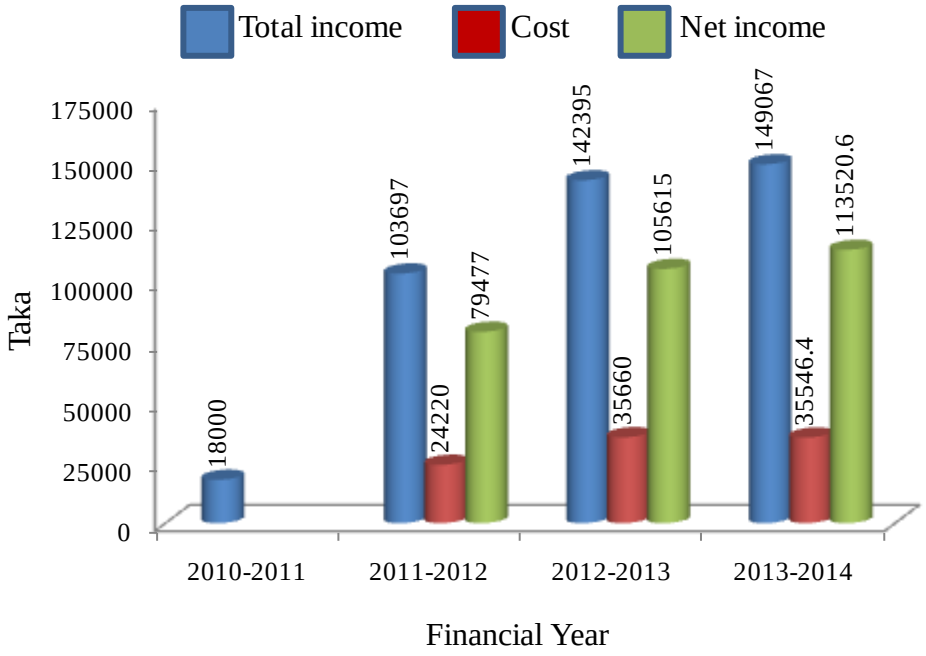

Fig. 33a. Comparative total income, cost and net income in different financial year in Mymensingh district

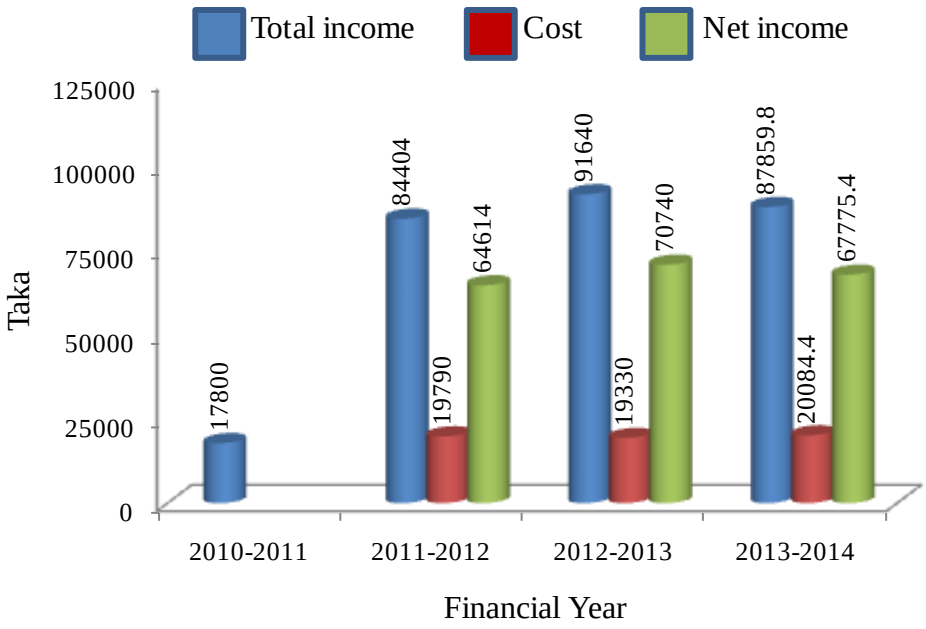

Fig. 33b. Comparative total income, cost and net income in different financial year in Jamalpur district

10.7 Farmers Training

Farmers training were organized every year (2011, 2012 and 2013) separately for Mymensingh and Jamalpur char areas with selected farmers (Fig. 34). In each year total 140 farmers were selected of which 70 from Mymensingh and 70 from Jamalpur. Total 420 {(70 + 70) × 3} farmers were trained up by different resource persons on concept of agroforestry, significance of agroforestry in the char areas of Bangladesh, concept of suitable agroforestry system for char areas, suitable timber and fruit species for charland, management of agroforestry based production system, nursery management and tree sapling plantation technique, green manuring, integrated pest management (IPM), and relationship between agroforestry and environment.

Mymensingh

Jamalpur

Fig. 34. Farmers training program in the char areas Mymensingh and Jamalpur district separately

10.8 Agroforestry models/Cropping pattern

Six different agroforestry cropping pattern or models were proposed for charland from the experience of last two year (2011-2013) experiment in Mymensingh and Jamalpur char areas. These are as:

1. Model/pattern 1: Akashmoni-Carrot/chilli/radish in winter followed by Kangkong in next summer season.
2. Model/pattern 2: Lambu-Bitter gourd in winter followed by - Okra/ Indian spinach in next summer season.
3. Model/pattern 3: Mahogony-Bitter gourd/Radish in winter followed by - Okra in next summer season.
4. Model/pattern 4: Mango- Amaranth in summer season followed by Bitter gourd/ sweetgourd/ Radish in winter season
5. Model/pattern 5: Guava-Okra in summer season followed by Radish/ sweetgourd in winter season
6. Model/pattern - 6: Karanja-Bittergourd in winter season followed by Kangkong in summer season

10. 9 Livelihood improvement situation in different parameters

After SPGR sub-project implementation in the char areas of Mymensingh and Jamalpur different livelihood parameters, viz., productivity, income, nutrition, resource pattern, technical knowledge, employment generation, market linkage and women participation were increased compared to existing situation (Table 44). All of these above livelihood parameters were again observed by field monitoring and interviewing farmers using questionnaire like benchmark survey. It was found that compare to previous condition farmers idea was improved regarding innovative technology, intensive cropping pattern, specific agroforestry model and training activities related to agroforestry and other production systems (Table 38). Peoples of both Mymensingh and Jamalpur char areas were well aware about modern varieties of crops/vegetables. Women and idle youth participation gradually increased in both Mymensingh and Jamalpur char areas for plantation, agroforestry and marketing activities (Table 44). Due to SPGR sub-project implementation and its different activities like motivation, demonstration, training peoples of both Mymensingh and Jamalpur char areas exchanged their view with other persons or organizations.

Table 44. Livelihood improvement parameters (System sustainability) in the research areas after project implementation

Sl. No.	Area of consideration	(Probable) Indicators to asses the sustainability	% farmers adopting/ utilizing the technologies			
			Mymensingh		Jamalpur	
			Kalibari	Gobadia	Gosherpara	Topkerchar
1	Productivity	Use of alternative option	6	5	0	0
		Innovative technologies	7	5	0	0
		Use of enhanced skill and knowledge	25	20	12	15
		Sharing of knowledge	20	10	5	5
2	Income	Use of modern varieties	35	30	25	20
		Innovative technologies	20	15	10	10
		Use more area under cultivation/production	15	10	10	5
		Increased production skill due to training	30	20	10	5
		Spot demonstration	30	20	10	5
3	Nutrition based on productivity (if any)	Consumption of vegetables, fruits increased	40	35	20	20
		Changed in consumption habit towards vegetables and Fruits	15	15	10	10
		Reduced no. of disease and frequency of attack	20	15	10	10
		Good appearance of family members	35	25	15	15
4	Resource pattern	Fuel wood production	20	10	10	10
		Used in homestead	10	5	5	5
		Intensive cropping pattern	10	0	0	0
		Introduction of homestead production models	15	10	0	0
5	Technical Knowledge	Young girls and boys are engaged for implementation of new technologies	30	40	50	45
		Training, field days, exchange of views with different type of people	50	45	35	30
6	Employment generation	Use of unutilized family labour	60	55	65	50
		Women participation in Agril. activities (85%)	20	35	30	35
		Huge hired labour used in Agro-forestry system and created employment	35	25	20	20
7	Market Linkage	Market linkage of the products	45	40	25	15
		Farmers directly sold their farm products to the traders with reasonable price	10	0	0	0
8	Woman participation increased	Homestead	60	70	75	80
		Tree plantation and nursery	45	40	45	35
		Marketing	5	5	0	0

10.10 Environmental parameters after SPGR sub-project implementation

Like benchmark different environmental parameters were again observed by field monitoring and personal interview using questionnaire (Table 45). It was found that different sub-parameters of biodiversity, soil quality, agrochemicals and pollution status improved positively compare to previous condition (before project implementation). Only fauna under biodiversity, water quality under soil quality remained unchanged. From this environmental information it was also clear that agroforestry practices were suitable in the char based farming system which would be helpful for maintaining sound environment.

Table 45. Environmental situation in parameters after project implementation in the char areas of Mymensingh and Jamalpur

Sl. No.	Environmental issue	Component	Impact / after (%)*	Degree of Impact				Remarks
				Small (<20%)	Moderate (20-50%)	Large (>50%)	None	
1	Biodiversity	Flora	70%			?		
		Fauna	20%		?			
		Genetic diversity	45%		?			
		Exotic varieties	20%		?			
		Local varieties/ cultivars	60%			?		
		Hybrids	35%		?			
2	Soil quality	Organic matter	55%			?		
		Chemical fertilizer use	17%	?				
		Soil salinity	--				?	
		Fertility status	65%				?	
		Microbial activity	40%		?			
		Heavy metal contamination	--				?	
		Water quality	50%		?			
3	Agro-Chemicals	Pesticide use	18%	?				
		POPs	--				?	
		IPM	40%		?			
		Pest infestation	12%	?				
		Bio-pesticides	60%			?		
		Health hazard	0%				?	
4	Pollution	Soil	--				?	
		Water	--				?	
		Air	--				?	

*** % of each component was determined considering the optimum value as 100.**

10. 11 Exchange visit

The Member Director, Natural Resource Management (NRM) Division of Bangladesh Agricultural Research Council (BARC) and the Coordinator of the "Coordinated project on improvement of agroforestry practices for better livelihood and environment" arranged this exchange visit for all the scientists engaged with the six different components of this coordinated project with a view to share experience, knowledge, views of the participating farmers and other related aspects. Thus the visits have been accomplished in three phases. The first visit was made from 8-10 October, 2012 to observe the experimental site of Bangabandhu Sheikh Mujibar Rahman Agricultural University (BSMRAU) component executing programs at Narsingdi and Kapasia; the Bangladesh Agricultural University (BAU) component executing research programs at Char Kalibari of Mymensingh Sadar Upazilla and Bangladesh Jute Research Institute (BJRI) component executing program at Rangpur site. The second visit was made in 15-16 November, 2012 to observe the BSMRAU compoinent's program executing at Paikgacha upazilla of Khulna district and Khulna University (KU) component's program executing at Dumuria Upazilla of Khulna. The third visit was made from 29 Nov. to 2 Dec.2012 to observe the Bangladesh Forest

Research Institute (BFRI) component and Chittagong University (CU) component's experimental sites implementing at different places of Chittagong, Khagrachari, Rangamati and Banderban districts.

During the first visit (held from 8-10 October 2012), the team observed the experimental plots of BSMRAU component on 8 October at Belabo (beneficiary farmer's name Md. Ataullah Bhuiyan). This farmer usually cultivated brinjal in his Jackfruit orchard (Jackfruit + brinjal based system, this was the existing system) and now he has introduced Jackfruit+lemon/malta +papaya+ vegetables based system. According to him, his income has been increased due to introduction of the new system. The farmer appeared to be happy with the new farming system. Then the team moved to Kapasia to visit the plot of Mr. Mozammel Haque of Borzona, Kapasia area. Previously this land remained fallow. The BSMRAU compoinent introduced guava+vegetables based system in this land. They did not meet with the beneficiary farmer. On 9th October 2012, they visited the experimental plots of BAU component at Char Kalibari. Char Kalibari previously remained fallow. In this char area, agroforestry systems, viz., timber tree+ vegetables, fruit tree+ vegetables and soil conserving tree+ vegetables have been introduced. The visiting team members shared their views with the beneficiary farmers. On 10th October, the team visited the BJRI experimental plot at BJRI research station. This experiment was set up in a 3-4 yrs mango orchard. The jute plants were in vegetative stage. The team also visited two research plots at Tilakpara village under Sukererhat Union of Mithapukur Upazilla, Rangpur. Both the research plots were mango based. However, the ages of the orchards were not similar. The team members suggested to select orchards of similar age group, so that the quality of jute seeds produced under these orchards may be compared with the varying shade level.

During the second visit (held from 15-16 November 2012), the visiting team observed the experimental plots of BSMRAU component executing at Paikgacha area of Khulna district on 15 November. The team visited the jujube orchards of Amal Krishna Mondal and Anil Krishna Mondal. In these orchards, different vegetables based systems were under trial. On the same day, the team also visited some experimental plots of BSMRAU component in the Paikgacha area where rice+pulses+mango based systems were under trial. On 16th November 2012, the team visited the KU component's experimental area at Dumuria Upazilla of Khulna district. This is the gher land component where the farmers used the dikes of their ponds for simultaneous cultivation of trees and vegetables. Different tree species, viz., mahogony, eucalyptus, akshmoni and lemon were planted and the interspaces were being used for cultivation of tomato, brinjal, lady's finger and different gourds.

During the third visit (held from 29th November to 2 December 2012), the team observed the experimental fields of BFRI component implementing at Khagrachar RARS station on 30 November where medicinal plants, viz., Ashwagandha, Tulsi, Basak, Satamuli etc. were cultivated along the slope of the hill. The farmers expressed their satisfaction regarding the income received from this farming practice. Then the team moved to Kaptai area of Rangamati district to observe the experimental plots of CU component and BFRI component. Here the CU component is introducing fruit based agroforestry systems along the hill slope. The BFRI component is cultivating the same medicinal plants in the hill slope. On Ist December 2012, the team went to Banderban to observe the research site of BFRI component. Here the farmers seemed to be more progressive. They are cultivating the same medicinal plants along the hill slope. They already established marketing channel and sold their harvest. They appeared to be happy with the introduction of this new farming system in lieu of cultivating turmeric which caused erosion of the hill slope.

Lessons learned from this visits: The research team visited the research plots of all the six different components of the "Coordinated project on improvement of agroforestry practices for better livelihood and environment" implementing in different ecosystems throughout the country. It appears that most of the components created public awareness through the participation of the farmers. The public opinion thus created also increased the confidence of the beneficiary farmers. In our opinion, the most important lesson learned from this program is the successful build up of the confidence of the farmers that the agroforestry farming systems can bring changes in their livelihood.

Recommendations/ Conclusion: In general, all the components made significant progress in achieving the targeted goal. However, from scientific consideration the following suggestions/recommendations have been made for technology generation view points:

i). The BJRI component which is engaging for jute seed production through agroforestry farming systems need to carefully investigate the quality of the seeds. Because they are producing jute seeds under varying levels of shade of the tree component.

ii). The gherland component which is utilizing the dikes of ponds of a gher should select the tree species which will not destroy the dike. Rather the tree species selected should stabilize the dike for its sustainable use for vegetable cultivation. The Mahogony tree planted in the dike may destabilize the dike in future, because it was a large crown tree spreading roots mostly in horizontal fashion. In this case, tree species belong to Monocot may be suitable.

iii). The BFRI component which is cultivating medicinal plants in the hill slope is supposed to determine the active ingredients of each of the medicinal plant. In this case careful

investigation is necessary whether the amount and types of active ingredients will be influenced by the varying shade levels. So the sample collection must be done after measuring the shade level before determination of active ingredients.

iv). As the agroforestry systems involved perennial trees/shrubs, it always cast some level of shade to the below ground crops, therefore, the other components must take careful consideration during developing agroforestry models for future use.

11. Research Highlights

i. Benchmark survey was successfully completed with 200 farmers and baseline database was prepared which have also been compared with data obtained after completion of SPGR sub-project.

ii. Successfully 7886 tree saplings of different timber, fruit and soil conserving species were transplanted on 6.85 ha of land which has become permanent asset of the concern farmer.

iii. Different winter and summer vegetables/crops were successfully cultivated during the year 2011-2013 in association with the planted different tree species resulting increased income of the participating farmers.

iv. Farmers income was determined from every research plot which was basis of benefit-cost estimation and it was found that 150-200% gross income increase compare to benchmark database.

v. Better livelihood and bio-diversified sound environment has been created in char areas of Mymensingh and Jamalpur which is reflected from environmental and livelihood parameters recorded before and after SPGR sub-project implementation.

vi. Six different Agroforestry cropping pattern are identified which will be successfully used by the farmers of char areas in Bangladesh.

vii. 420 farmers have successfully trained up regarding agroforestry, social safeguard and environmental concept.

viii. Under this project 15 MS thesis and One Ph D dissertation were written.

ix. Seven different scientific research articles were published in the journal of agroforestry and environment.

12. Major Attainments (*in relation to set objectives*)

a. Technical (Output, Outcome and Impact)

Sl. No.	Major technical activities	Output	Outcome	Impact	Remarks
1.	Benchmark survey	Information collection on existing status of the project site	Database prepared on existing status	Awareness and motivation on agroforestry	
2.	Tree sapling plantation	7886 sapling planted on 6.85 ha charland	Fuel wood and fruits obtained from trees	providing timber, fuel wood, agroforestry pattern and sound environment	
3.	Vegetables/crops cultivation	Different summer and winter vegetables/crops cultivation with trees	Increase yield obtained from different crops	Identify different suitable agroforestry pattern for charland	
4.	Farmers income measurement	Total income increased from agroforestry activities	Net income increased from vegetables/crops and tree products.	Livelihood and social status improvement	
5.	Tree growth observation	Height and girth determine in every season (summer/winter)	CAI and MAI measurement	Silvicultural characteristics known	
6.	Livelihood and environment parameters observation	Recorded different parameters of livelihood and environment	Compared with previous status	Clear concept on environmental and livelihood changing pattern	
7.	Farmers training	420 farmers trained up on agroforestry activities	Motivated on char based agroforestry farming	Gained knowledge about environment and social safeguard	
8.	Participation in the exchange visit	Sharing/exchange the ideas on different agroforestry ecosystem	Enjoy the actual situation of different sub-project component	Help to achieve the target goal of the sub-project	

b. Procurement

Sl. No	Approved provisions of procurement	Achievements	% of achievements	Remarks
1.	Planting materials	Seedlings/saplings of different timber and fruit species were transplanted	100	
2.	Vehicle hiring	The supplier supplied all required vehicles as per our demand	100	
3.	Office and lab equipments and small transport viz. furniture, Laptop, Photocopier, Camera, Multimedia projector, Printer, Quantum and Sunshine duration sensor and Motor cycle.	The supplier supplied equipments and furnitures	100	
4.	Bi-cycles	Cash purchase from local market	100	

c. HRD/Training

Title (e.g.Ph.D/ MS/ training/ workshops etc.	Target	Attainments	No. of participants	Benefits of the higher studies/ training	Remarks
Ph.D	1	100%	1	Technologies generated through the Ph.D/MS research work will help the farmers to adopt sustainable agroforestry production system	
MS	20	75%	15		
Farmers Training	600	70%	420	Obtained knowledge on agroforestry practices, management, environment and social safeguard which resultantly improved livelihood condition..	

d. Financial Progress

Sl. No	Major Head	Fund released (Tk.)	Expenditure (Tk.)	Balance (Tk)	Remarks
1	Salary & Remuneration	2339503.33	2346884	-7380.67	
2	Research expenses	1590475.00	1602429	-11954	
3	Operating expenses	580461.67	584268.6	-3306	
4	Fuel, Oil and Maintenance	515150.00	515150	0.00	
5	Workshop/Seminar etc.	300000.00	300000	0.00	
6	Publications & printing	130000.00	130000	0.00	
7	Contingencies	148440.00	125000	23440	
8	Capital expenses	942900.00	942900	0.00	
Total		6546930.00	6546631.6	298.4	

e. Materials developed/publications made

Type of material/ publication	Title	Number	Remarks
Technology development	Agroforestry cropping pattern or models for charland	6	
Journal publication	1. Alam, Z., Wadud, M.A. and Rahman, G.M.M. 2012. Performance of summer vegetables in charland based Agroforestry system. J. Agrofor. Environ. 6(1): 1-8. 2. Babu, A., Toser, G.S., Alam, Z. and Rahman, G.M.M. 2012. Boundary plantation of Eucalyptus and its effect on chilli and sweet gourd. J. Agrofor. Environ. 6(1): 43-46. 3. Hasan, M.R., Akter, A., Alam, Z. and Wadud, M.A. 2012. Indian spinach and okra cultivation along with *Swietenia hybrida* tree as Agroforestry practices. J. Agrofor. Environ. 6(2): 119-124. 4. Rahman, M., Alam, Z., Mondol, M.A. and Rahman, G.M.M. 2013. Performance of sweet gourd in association with Eucalyptus saplings. J. Agrofor. Environ. 7(1): 19-21. 5. Bali, S.C., Mondol, M.A., Akter, A., Alam, Z. and Wadud, M.A. 2013. Effect of guava and lemon on the yield of okra under Agroforestry system. J. Agrofor. Environ. 7(1): 53-56. 6. Rahman, A. Hossain, M.I., Akter, A., Wadud, M.A. and Rahman, G.M.M. 2013.	7	Published in the different issues of the Journal of Agroforestry and Environment

	Performance of sweet gourd grown in association with Akashmoni saplings. J. Agrofor. Environ. 7(1): 61-64. 7. Ahmed, M.N., Mondol, M.A., Hossain, M.I., Akter, A. and Wadud, M.A. 2013. Performance of kangkong under two years old Akashmoni tree. J. Agrofor. Environ. 7(1): 89-92.		
Booklet/leaflet/flyer etc. published	Technical Bulletin on "Coordinated project on improvement of Agroforestry practices for better livelihood and environment: BAU component"	1	
Any other (patenting of technology etc.)			

13. Sub-project Auditing (cover all type of audit performed)

Types of Audit (e.g BARC/Implementing agency/FAPAD/World Bank/others)	Major observations/issues/objections raised, if any	Status at the sub-project end	Remarks
BARC appointed 'J.U. Ahmed & Co. audited once in a year.	Minor mistakes regarding the maintenance of cash book and preparation of SoE were pointed out	Satisfactory	
FAPAD audited once in a year.	Do not raise any objections.	Satisfactory	

14. Reporting

Report type	Date of submission(s)	Total Number(s)	Remarks
a. Inception report	28.06.2011		
b. Monthly report	Within the 7th of each month	34	
c. Statement of expdts.(SoE)*	Within the 7th of each month	34	
d. Quarterly report(s)*	Within 10 days of the end of each quarter	12	
e. Half yearly report	with in two weeks of the begining month of next half year	06	
f. Procurement plan	3/07/2011	01	
g. Annual report	At the 4th week of of the last month of each year	03	
h. Environmental monitoring (Annual Basis)	Once in a year	03	

i. Social safeguard status (Before and at the end) 1. Before 2. After	 15/06/2011 17/02/2014	02	
j. Field Monitoring Report(s)**	once in each quarter	11	By internal monitoring team

** Provide all since start to end.*

*** Conducted at the local level by implementing agencies.*

15. Problems/Constraints(bullet points- max. 5 nos.)

1. One and half month long flood during 2012 heavily damaged the plantation in the char areas of Jamalpur districts.

16. Suggestion for future, if any

This sub-project already identified some potential Agroforestry production patterns which proved economically more profitable than the existing monocropping systems. However, short period (2/3 years) observation is still premature to conclude the findings because the Agroforestry production system is more complex than the monocropping one. Therefore, for more conclusive achievements further research are needed to develop these agroforestry patterns into established models.

17. References

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Signature of the Coordinator/Principal Investigator(as applicable)
Date …….
Seal

Counter signature of the Head of the agency/authorized representative
Date ……..
Seal

18. Appendix-1

List of equipments procured through this project and its present status

Name of the equipments	Price (Tk.)	Location of the equipments	Users
a. Lab equipments: 1. L1-190SL Quamtum Sensor 2. CSD 3 Sunshine Duration Sensor	 140000.00 210000.00	Departmental post graduate lab.	MS and PhD students
b. Office equipments: 1. Laptop computer 2. Printer 3. Multimedia projector 4. Photocopier 5. Digital camera	 80000.00 25000.00 80500.00 119000.00 21000.00	In the office room and teachers sitting room of the Department	Office personnels and teachers of the Department
6. Motor cycle (1) 7. Bicycle (2)	149000.00 18800.00	Departmental office	Teachers and Departmetal staffs
8. Furniture: i. Secretariat table (2) ii. Visitors chairs (6) iii. Almirah (1)	99600.00	In the office room of Prof. Dr. G.M. Mujibar Rahman and Prof. Dr. Md. Abdul Wadud	Prof. Dr. G.M. Mujibar Rahman and Prof. Dr. Md. Abdul Wadud

This is to certify that the above mentioned euipments have been recieved by me from the Principal Investigator of the "Coordinated project on improvement of agroforestry practices for better livelihood and environment: BAU component" and duly enrolled in the stock register of the Department of Agroforestry, and those will be used henceforth as shown above.